PRACTICAL
ENGINEER

VOL. XVI CHICAGO, MARCH 15, 1912 No. 6

HEATING AS A PLANT BYPRODUCT

Atmospheric Pressure System as Used at the American District Steam Co.'s Plant

R-R-R-R! BUT IT'S RAW outside this morning!"

"Yep, but the new heating system has got the shop quite comfy."

"Well, this return pipe is cold enough."

"That so? Feel the radiator; that's hot."

"Sure enough, right down to near the bottom, but the return is barely warm."

"Well, that's the way she ought to be. That's the way it's meant to work. We want the heat in here, not in the sewer."

Thus ran the talk in the new shop on a winter's morning when sleet and low temperature made outdoors a thing to be admired with relish only through the windows of a comfortable room, and the system under discussion was that installed for heating a great building with a steam pressure of 5 to 8 ounces at the radiator.

The size of the new shop which is thus heated and of the rest of the plant, all which is heated with exhaust steam from the power plant engines, is sufficient to make a study of the system of particular interest. Covering over 150,000 sq. ft. of floor space distributed among 10 buildings and spread as shown in Figs. 1 and

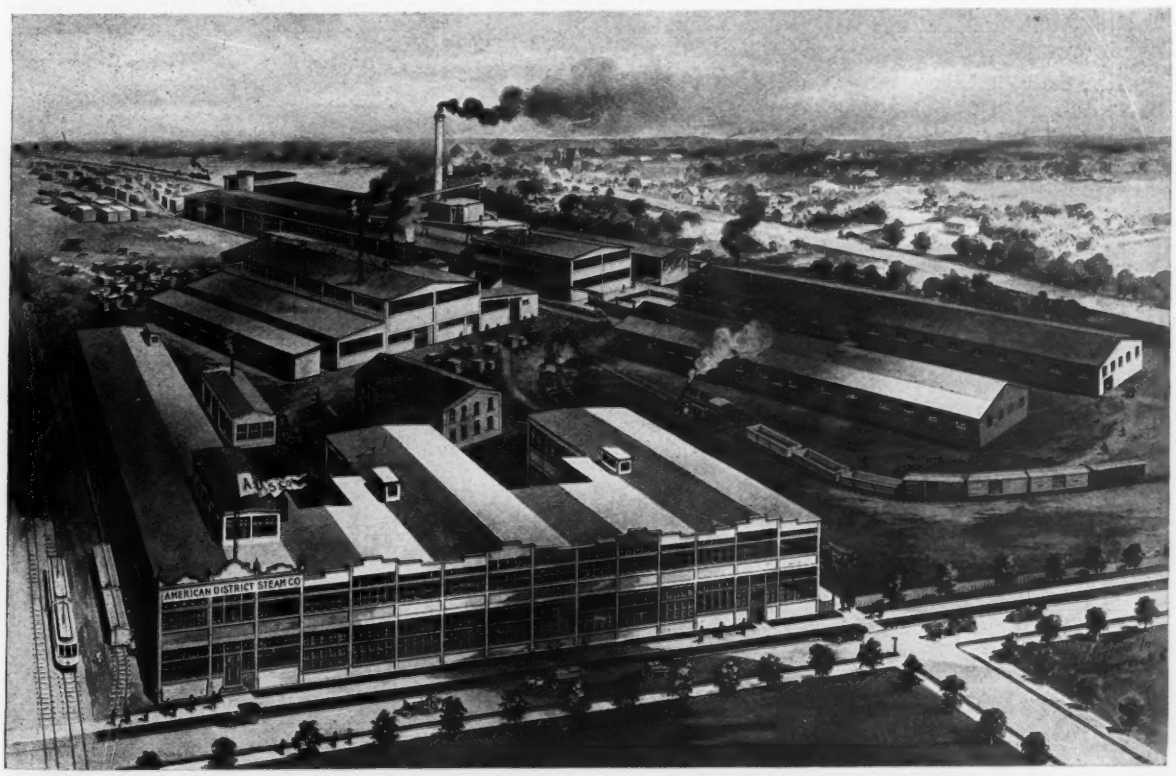


FIG. 1. GENERAL OFFICES AND WORKS, AMERICAN DISTRICT STEAM CO., NORTH TONAWANDA, N. Y.

2, the plant would seem to call for a large expense for heating and the use of high pressure steam. But the business of the American District Steam Co. is to help other people solve their heating problems and to save elusive dollars that otherwise will escape, and the company practices what it preaches.

The plant is, therefore, heated by distribution of exhaust steam through underground mains, some live steam being used for industrial purposes. In the older buildings, which have been in use for some time, a regular form of low-pressure heating system is used, taking steam at from 3 to 5 lb. pressure, but in the machine shop recently completed the steam is supplied to radiators as already stated at a pressure of only 8 ounces, and furthermore the supply of steam is so regulated that ¼, ½, ¾ or the entire amount of heating surface may be supplied with steam, thus regulating the temperature to suit the weather.

Power Generating Plant

AS the generation of power in such a system precedes the use of the steam for heating, that order will be followed in the description of the installation. The location of the power plant is indicated by the brick stack in Fig. 1, but this stack does not, as the artist has indicated, busy itself with the production of black smoke. It is, on the other hand, a well behaved and orderly stack which is occupied with carrying away the products of well regulated combustion and serves the boilers which generate the steam for the plant.

These boilers are located as indicated on Fig. 2 in the boiler room at the far end of the power house with a passage way running between. There are 2 Stirling boilers made by the Babcock & Wilcox Co. and each has 170 3¼-in. tubes, 3 36-in. steam drums and 1 42-in. mud drum, the drums being made of open-hearth steel with tensile strength of 56,000 lb. and designed to carry 150 lb. working pressure, although 112 lb. is now in use. The higher pressure will, however, be used when some alterations and the installation of a new heater now under way are completed.

For fuel, when the casing shop is running full, shavings from the construction of the wood piping are brought by fan and cyclone direct to the furnaces and make most of the supply of fuel needed although some coal is kept burning on the grate to even up the steam pressure. When the casing mill is not in operation, run-of-mine coal is used, hand fired.

Feed water comes either from the returns or from the city supply. The heating returns are brought back from the lumber drying kiln and the casing mill to the hot well at a temperature of 130 to 170 deg. and the supply is drawn from this hot well by either of

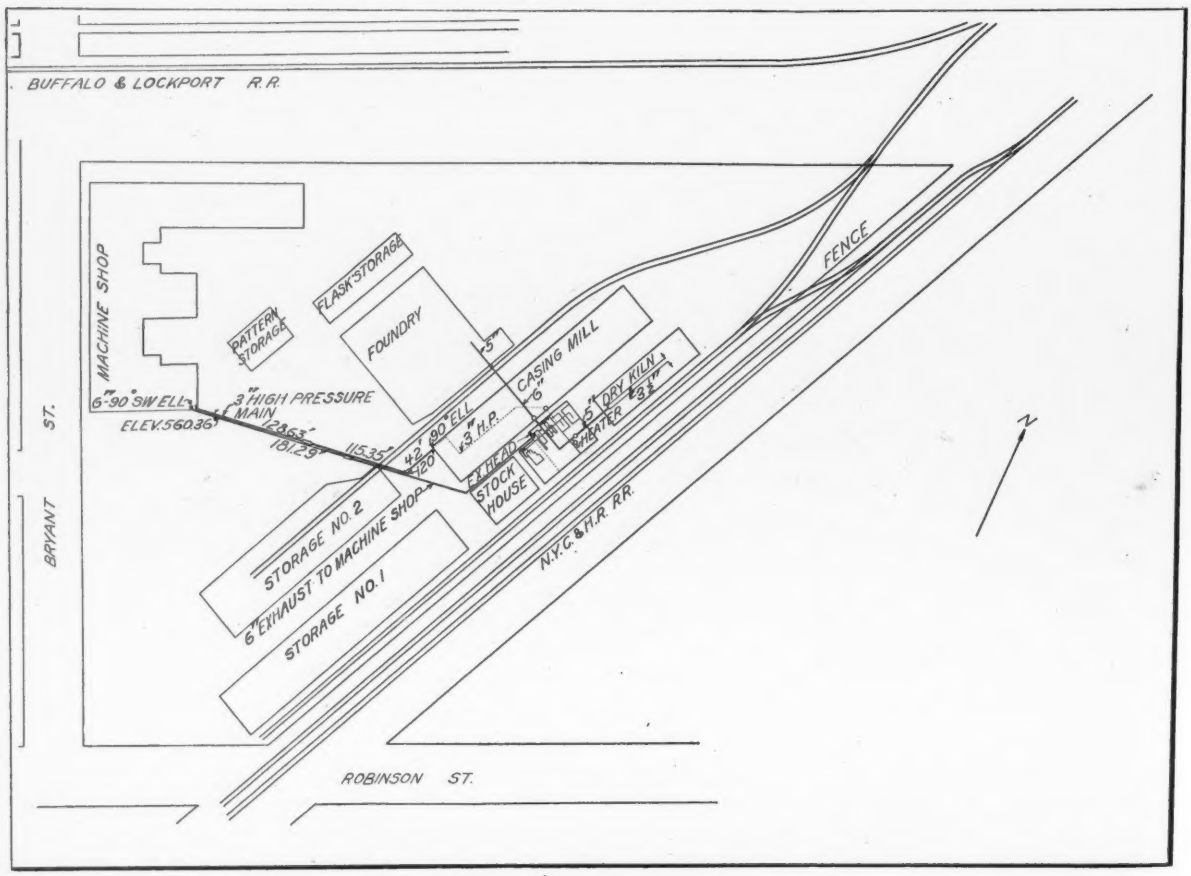


FIG. 2. PLAN OF AMERICAN DISTRICT STEAM CO.'S PLANT

2 Worthington duplex boiler feed pumps and sent to the boilers, either through a Wainwright heater, or direct when there may be occasion to inspect or repair the heater.

Piping for each pump is arranged with shutoff and cross-over valves so that either pump may draw from the hot well or from the city supply and either pump

may feed either boiler direct or through the heater. The condensed steam from other buildings than the casing mill and dry kiln is arranged with an economy coil to take out all heat possible, and is then discharged into the sewer.

Steam is supplied to the casing mill through a Squires reducing valve arranged with a bypass as indicated in the boiler room piping, at 65 lb. pressure for use in heating asphaltum for the coating bath. Both boilers feed steam into a header and the lines for the casing mill and for the pumps are taken from this header. On the line which supplies the pump a Squires reducing valve is placed, to reduce the pressure to 5 lb. for supplying the kiln in case exhaust from the engines is not sufficient. A line, as indicated on the plan drawing of the plant, Fig. 2, is also carried to the main shop for testing, but this line is not connected in any way with the heating system.

After passing these branch supply lines, the header drops and passes through the partition between engine and boiler room to supply the 3 generating units, connection to these units being made by long radius bends through Cochrane separators.

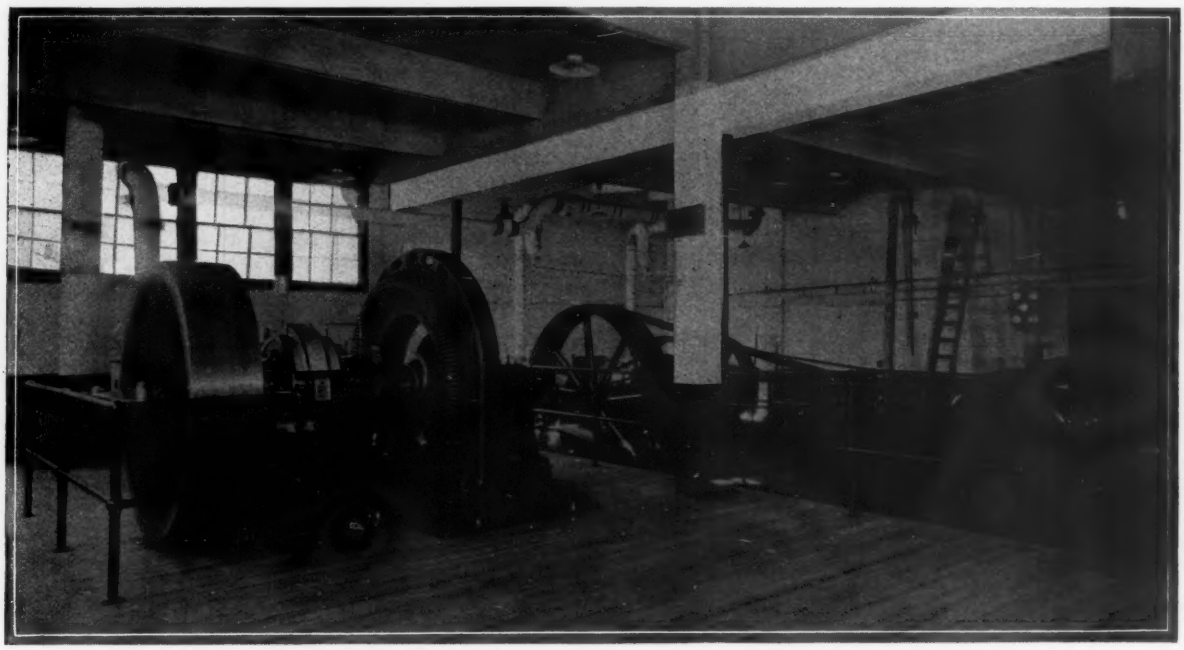


FIG. 3. GENERATING UNITS AND PIPING

As shown in the photograph of the power plant, Fig. 3, all piping is well covered and the separators are provided with drip pipes and expansion is well taken care of. Three units are installed for the generation of electric current, all supplying 3-phase current at 440 volts. The first unit nearest the boiler room consists of a McIntosh & Seymour high-speed simple engine belted to a Western Electric 150-kw. generator which runs at 900 r.p.m. From the end of the generator shaft a belt is carried to the exciter which is a 5-kw. machine running at 2050 r.p.m. and supplying current at 120 volts.

The second unit consists of an Atlas-Corliss engine belted to a Hawthorn generator of 125 kw. capacity running 600 r.p.m., and this in turn is belted to its exciter, which is a 5-kw. machine running 1800 r.p.m. These units which were in the older part of the power plant are now used as relays or in times of light load when it is desirable to shut down the new and larger unit.

This No. 3 unit, Fig. 5, consists of a Skinner tandem-compound engine 14 and 22 by 18 in., running 225 r.p.m. and designed for 150 lb. initial pressure. It is a direct connected to a Hawthorn alternating-current generator 185 kilowatts capacity, having the direct-current exciter mounted on the generator shaft close to the revolving field of the generator. The exciter is a 10-kw. machine at 125 volts.

The Skinner engine is of the latest type with automatic lubrication, the oil being circulated by a pump located inside the engine frame and pumping oil to a reservoir above the guides. From this it is distributed by gravity to all bearings on the engine, the size of the stream at each point being regulated by a needle feed. The oil after passing through the bearings flows to a chamber in the base where it is filtered and washed before being returned to the reservoir. The cylinder is lubricated by means of a Rochester 2-feed positive lubricator. Indicator piping is provided and the engineer is supplied with an indicator so that he can at all times keep track of the power being generated by the engine and of the action of the steam valves.

Exhaust from all engines goes to the same underground line, Fig. 4, which has a connection in one direction to the lumber kiln with a branch to the feedwater heater, and in the other direction goes through an underground tunnel to supply heat for the buildings about the plant. For each engine there is also an outboard exhaust with G. M. Davis relief valve that may be set at from 3 to 5 lb., so that if the supply of exhaust steam exceeds the demand for all purposes, some of it will be discharged to atmosphere. Exhaust from the Skinner engine passes through a Cochrane oil separator before going to the distributing line.

Switchboard Connections

CURRENT passes from each generator through underground ducts to the switchboard which is shown in Fig. 5, and the distribution is as indicated in the sketch of switchboard connections, Fig. 6. Each generator has its own switchboard panel, and the connection of the generator is to a double throw oil switch which may be thrown either upward to the power bus bars or downward to the lighting bus bars. Power current is carried straight across the switchboard through totalizing wattmeter coils to the power bus bars which supply the power distribution panels. The lighting bus bars for the lighting distribution panels are located lower on the board than the power bars.

Usually both light and power are carried on the same generator, the break switch indicated being closed. If it is desired to separate the light and power supply, the break switch is opened and one generator thrown into the lighting bus bars, another onto the power bus bars.

Power is distributed from 3 panels to different buildings and light is likewise carried on 3 panels for 3 different groups of buildings. Provision is made for connection of the lighting system to the street circuit through a double throw switch which controls the bus bars on the lighting panels, and a single throw switch which controls the street circuit connection but power cannot be supplied from the street mains.

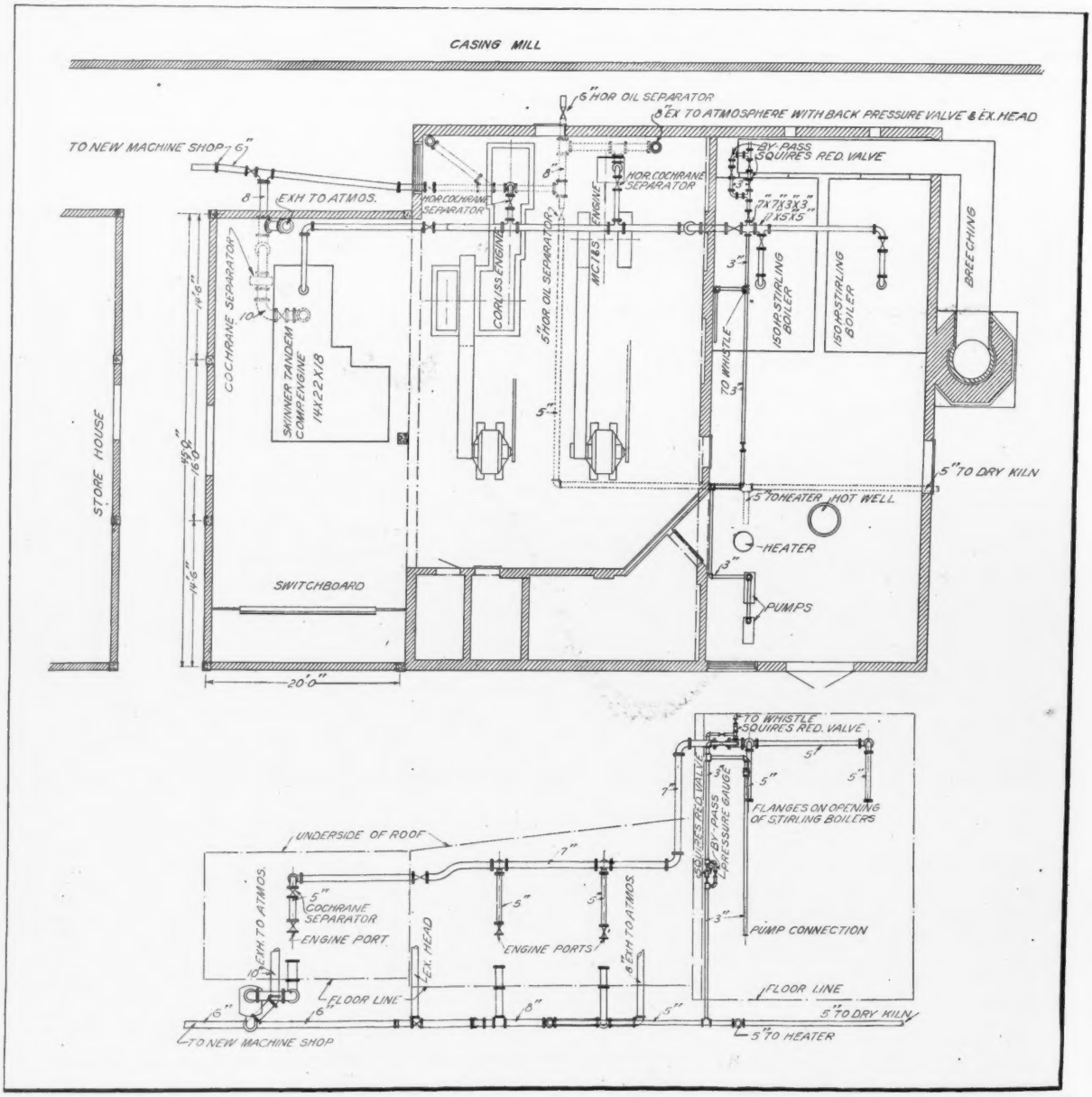


FIG. 4. PLAN OF POWER PLANT AND ELEVATION OF STEAM PIPING

Each generator panel is equipped with a Ward-Leonard double rheostat control for the fields and main circuit of the exciter. An alternating-current voltmeter, 3 alternating-current ammeters, a direct-current voltmeter and ammeter for the exciter, also with the regular field switches, synchronizer and voltmeter

switches and a main double throw oil switch. The General Electric synchronism indicator is mounted at the end of the board next the generator panels.

In the center is a totalizing panel equipped at the top with a Wagner power factor meter, a General Electric recording wattmeter and a Thompson watt-hour meter. Also on this panel is the break switch for controlling connection to the lighting bus bars. Each power panel is equipped with ammeter and wattmeter, and an I. T. E. Type W circuit breaker, and each lighting panel is equipped with ammeter, wattmeter and 3-pole blade switch with enclosed fuse. On one of the panels is also mounted the double-throw switch for controlling the street connection. By this arrangement of panels, switches and wattmeters it is possible to charge to each department the amount of current it uses for both light and power and thus a close check is kept on the power cost of each.

Current is carried out to the different shops at 440 volts and is fed to the motors directly at this voltage. For the lighting, each building is supplied with a transformer which reduces to 110 volts. Larger machines and those taking considerable power are equipped with individual motors, while the smaller machines are group-driven with a motor driving the countershaft of each group.

An illustration is as shown in Fig. 7, a view in the casing shop. Here the winder seen in the foreground, the machine for cutting the tube ends which is directly behind, and the coating machine still further in the background, are driven by a single motor which is just indicated at the upper right hand corner of the illustration, and which drives a countershaft from which all the machines are belted. A similar arrangement on the other side of the shop drives a winder, an end mortise and tenon machine and an emery grinder.

Woodworking machines, such as the saws, planer and groovers, are supplied with separate motors. The staves for the pipe are made from square pieces of pine which are slit lengthwise on a bevel, each piece making 2 staves. The piece is then run through a grooving machine which shapes the top and bottom, planes the sides and puts a tongue on one side and a groove on the other to make a tongue and groove joint between segments. Each of these planing and grooving machines carries a 20-hp. motor; each of the band saws on which the staves are slit, carries a 10-hp. motor.

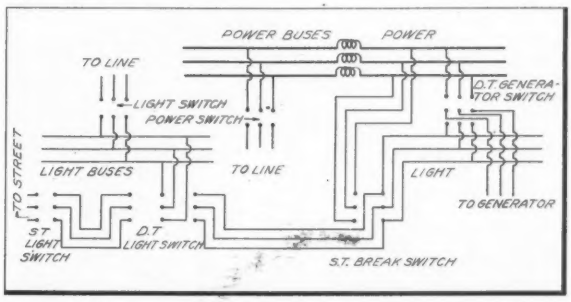


FIG. 6. CONNECTION DIAGRAM OF SWITCHBOARD

Above the tools are the fans which draw the shavings from the machines and blow them to the cyclone over the boiler house. A single fan takes the shavings from both of the end mortising machines and is driven by a 20-hp. motor. The fan for the circular and swing saws and that for the planing and grooving machines are driven by a single 35-hp. motor.

Lighting for the mill is controlled by a panel board located near the entrance. Each individual motor is controlled by a starting box located near the machine, and the group drive motors by a starter located near the motor. This system of driving is typical of that used in all other parts of the plant, the arrangement of the motor and the automatic reversing switchboard for a large planer being shown in the machine shop view, Fig. 8. Also the top mount of some smaller

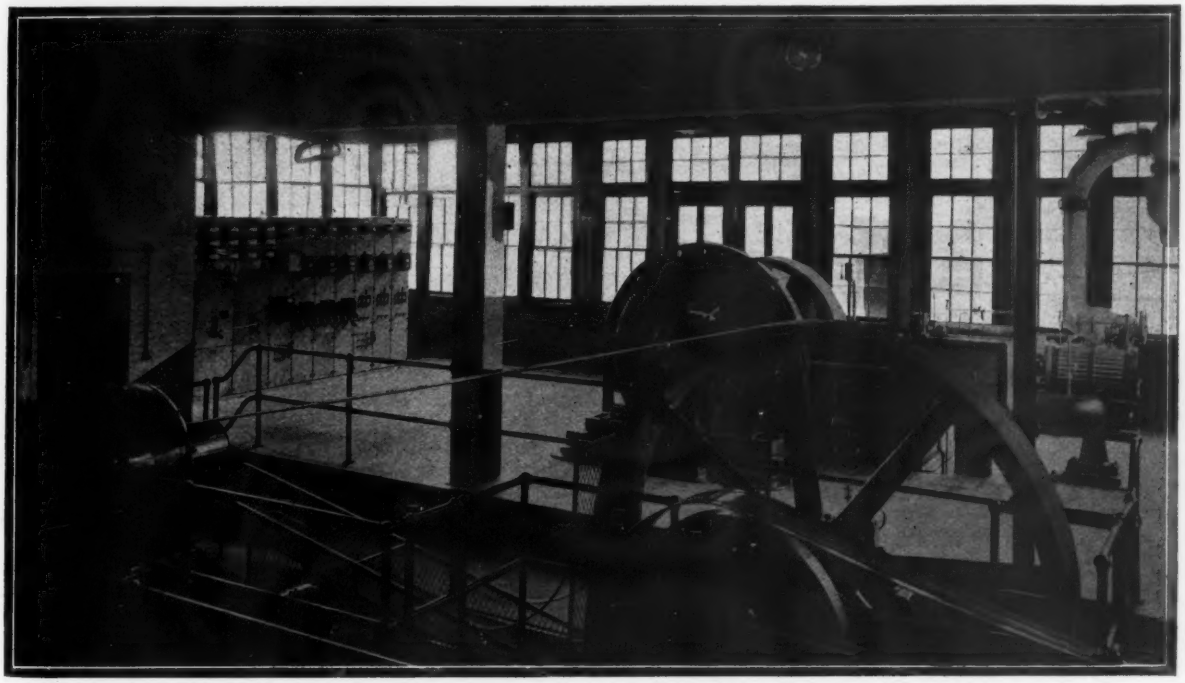


FIG. 5. LARGE GENERATING UNIT AND SWITCHBOARD

motors for other tools is indicated in this view and over the tool room will be seen one of the suspended motors for group drive.

In the foundry the chief uses of power are compressed air for the lift and the Tabor moulding machines; this compressed air being supplied at 75 lbs.

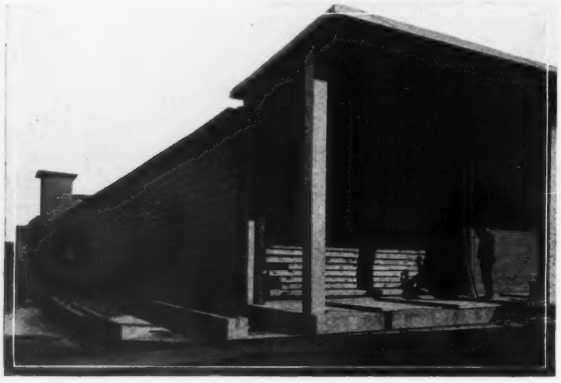


FIG. 9. DISCHARGING END OF KILN FOR LUMBER DRYING

pressure by a 12 by 14 in. compressor running at 120 r.p.m. supplied by the Chicago Pneumatic Tool Co., and belted to a 50-hp. induction motor. This outfit is located in a shed at one side of the shipping room of the foundry and supplies blowing pressure for the cupola as well as for other work. The cupola is a 60-in. reduced by lining to 48 in. for making the castings required for the meters and other apparatus for the underground heating systems.

Exhaust Steam

THE use of exhaust steam for heating feed water is as usual in power plants, the steam being sent through the Wainwright heater and feed water pumped through on its way to the boiler. For the dry kiln, steam at 3 to 5 lb. pressure is used in order to maintain a temperature of 145 deg. at the green end of the kiln and 160 deg. at the dry end. This kiln is 105 ft. long, 17 ft. wide and 11 ft. high, and has 2 tracks on which trucks of lumber are carried. At the far end of the kiln, Fig. 9, the green lumber is loaded on trucks and placed on 2 tracks, which slope the length of the kiln. The lumber passes slowly along, the incline of the track being about 12 in., and in the course of three weeks passes out of the dry end thoroughly seasoned.

The space in the kiln is 19,660 cu. ft. and to heat this 4 coils are installed, 2 for each track, containing in all 25,000 ft. of 1-in. pipe. These coils extend about ⅔ the length of the kiln, the green end being without direct steam heat. A tower is supplied as shown in the illustration for carrying off moisture and heated air, gravity circulation being sufficient for the purpose. To check the temperature which is being maintained in the kiln, Bristol recording thermometers are installed in the engine room, to give the temperature at the green end and at the dry end.

Heating

HEATING from a central plant depends, for its economy, upon proper installation of the distributing system. The central heating plant presents not only to city central lighting and power stations but to factory plants which have a central power station, a means of condensing the steam to the best advantage and with the greatest profits. In the plant installation

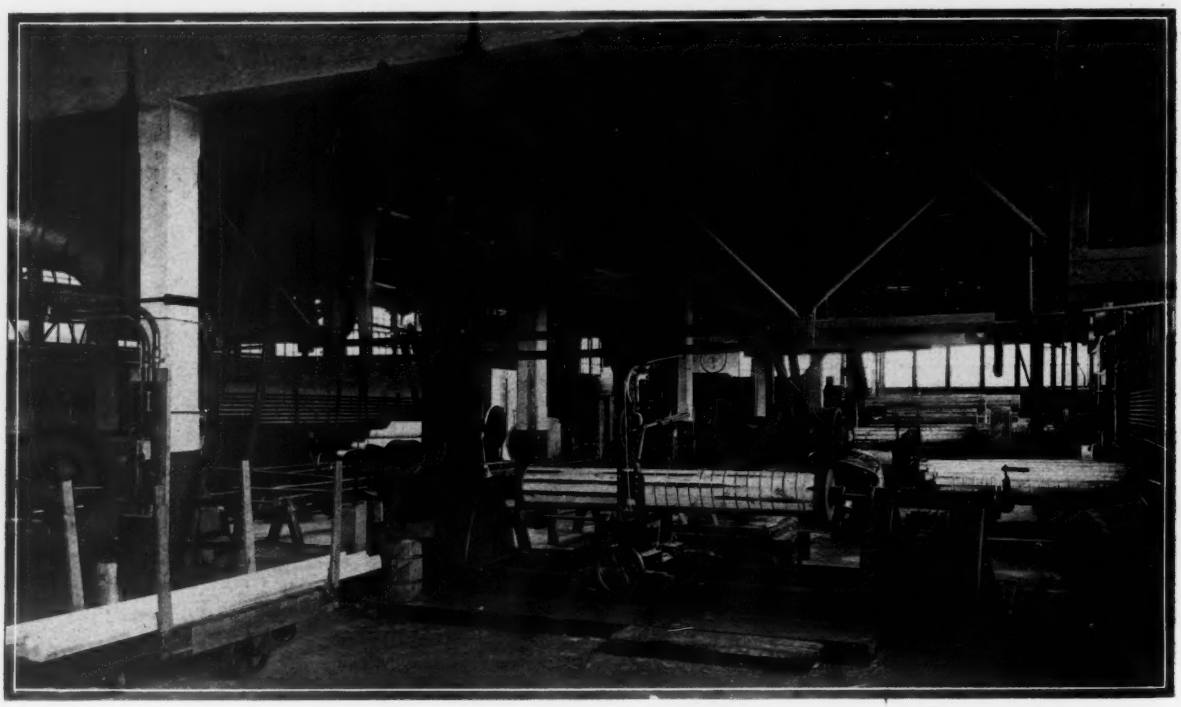


FIG. 7. VIEW IN CASING MILL SHOWING BINDING, END TENONING AND COATING MACHINES ON GROUP DRIVE

as well as in the central station, the best economy is secured by supplying light, heat and power all from a single boiler installation. The American District Steam Co. has given years of thought and experimenting to the development of its present system of underground distributions which is now known as the "standard."

Figure 11 gives in plan and sectional elevation the general method of construction of this system. The line is ordinary wrought-iron pipe, but should be carefully chosen under strict specifications as to weight, test, chemical composition, length and type of threads, recess couplings, etc., in order to insure steam tight construction. This pipe is laid inside a wood casing and has at intervals provision for taking off branch lines, for anchor stations and for expansion which may be by means of slip joints or "variators" as desired. The variators may be either single or double, a single variator taking care of the expansion of 50 ft. of pipe and a double variator of 100 ft. The anchor joint is placed midway between variators and holds the center of the section rigid.

Movement of the pipe is taken care of by laying it on roller saddles placed every 7 ft. inside the wood casing tube. The slip expansion joint is made in the usual form either double or single with brass slips, and in addition to the usual form of packing has water rings which make it unnecessary to pack the glands as frequently as with the ordinary type of joint.

Provision for changing the angle or grade of a pipe is made by means of adjustable angular wedges to be

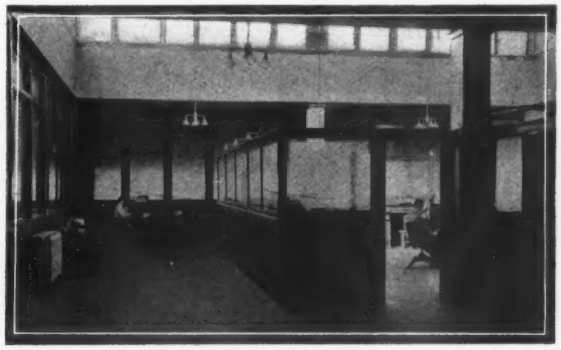


FIG. 10. GENERAL OFFICE SHOWING ATMOSPHERIC SYSTEM RADIATORS

put between flanges and by 90-deg. angle joints made so that they may be bolted together in any position.

(Continued on page 326.)

LOCOMOTIVE had a habit of running hot quite often. The fireman hadn't been long in this country, not long enough to get acquainted with the different scents arising from an engine.

Starting to drift down a hill the engineer said to the fireman: "Lean out the window and use your nose and tell me when you smell her warming." A skunk tried to cross the rails too late, and as the evidence came floating up, the fireman came back into the cab, yelling, "Stop her! Stop her! She's burning up!" C. S.

FIG. 8. NORTH WING OF MACHINE SHOP, GROUP AND INDIVIDUAL DRIVE

The variator is a packingless expansion, the come and go being taken up by corrugated copper diaphrams of which the outer edge is held in the iron casing of the variator and the inner edge is bolted to the end of the pipe.

ROUTINE AND RECORDS*

Importance of Knowing What Is Going On In the Refrigerating Plant

By John E. Starr

THERE HAS NOT been much said about refrigerating plants as they exist to-day, and what can be done with the apparatus now installed in order to cut down manufacturing costs.

Much can be done if you will start in a careful analysis of costs, and this can be most effectively reached by the operating engineer keeping for himself certain records and figuring out for himself the logical conclusions that can be drawn by an analysis and comparison of these records.

The Operating Engineer's Desk

ONE of the most important features of the boiler room and engine house in an ice-making establishment is the desk of the operating engineer. This desk should not be a shelf tucked away in some obscure corner on the top of the forecooler, or a board laid over an old ice can, but a good, self-respecting desk, with drawers and pigeonholes, and, maybe, a roll top, provided with a good light and a comfortable chair in front of it.

I like to see an operating engineer spending a good bit of time every day at such a desk, keeping books, recording his daily run, setting down his daily output of ice, his coal tonnage, water meter readings, labor, supplies and all the other items that go to make up cost; sifting them, analyzing and comparing them day by day and month by month, and it is no harm if he leans back in his chair and puts his feet on the said desk and smokes a reflective cigar, so long as his reflections are in the line of trying to discover by virtue of the comparison of the figures in front of him how he can chop off a little here and a little there from each item that goes to make the total.

A good engineer should have plenty of time to devote to this desk. If he is a man who has the ability to smell trouble from afar, and to meet it half-way or one-tenth of the way, the care of his engine room (if he has half a chance in the way of good equipment) should not take up much of his time.

I know an operating engineer, and he is a good man, who always has his plant in apparently good shape, but when he expects the boss he makes a dive for the oil can, smears his hands with oil, rubs them in coal pile and smudges up his face, grabs a monkey wrench and starts pulling up imaginary loose nuts. The boss comes around pretty often, and it keeps Jim in a continual state of smudge and futile labor.

The boss said to me one day, "Jim is a fine engineer; he is always at work. I never go into the engine room but that I find him busy at something."

I asked the boss what his ice cost him, and he replied, "Oh, about so much." I asked for some details, and he couldn't give them, remarking, "that the only practical way to get at the cost was to divide the whole year's expense by the whole actual amount sold. Then you couldn't fool yourself."

Then I asked Jim about it. I asked him what his displacement per minute per ton of ice made, what proportion of steam his main engines used, and what proportion his auxiliaries used, what was the relation of his engine indicated horsepower to his compressor indicated horsepower, what was his coal cost and labor cost per ton of ice made for each month, etc., etc.

Jim didn't know exactly. He admitted that he ought to know, and admitted that he could know; "but if the boss saw him wasting his time figuring up these things he (the boss) would take a fit."

This is an extreme case perhaps, but there are many similar cases, differing in degree.

Boiler Efficiency

NEXT to the time spent at the desk engaged in making and analyzing records, the engineer should spend a very considerable part of his time in the boiler room.

Why is it that when you are buying coal that should give you an evaporation of 7½ or 8 lb. of water per pound of coal in an old-fashioned distilled water plant, you are only making 4½ to 5½ tons of ice per ton of coal? If your auxiliaries are not using more steam than they ought to, or your skim waste is not more than it ought to be (both facts which should be shown by an analysis of your engine-room records), the fault is either in your boilers or in your firing.

The engineer is supposed to know more about firing than the average fireman; he should be provided with a separate water meter for boiler water alone, and if he can't afford a coal weigher, he can at least make an approximation of his daily consumption of coal by barrow measurements, and he is supposed to put down these measurements of water and coal in that record book on his desk each day, and get a pretty fair line on his evaporation.

He ought to know what evaporation he can reasonably expect from a ton of coal of a given quality, and if he is not realizing this expectation to find out, why not?

It takes time and patience and daily study of the figures to do it, but it can be done and is done.

I have in mind a case where a low-grade coal was used that on its analysis should have shown 6½ to 1 evaporation. They used 12 tons a day, costing $2 per ton, $24. The owner put in a weigher and a separate boiler-feed meter. The engineer kept his records and found he was getting 4 to 1. Inside of 2 months he was boiling the same amount of water, 48 tons, with 8 tons of coal, or 6 to 1 evaporation, and saving $8 a day. The last I heard of him he was worrying about that odd ½ pound.

It was not an easy job.

He had to spend a lot of time in the boiler house to do it, but he got there. He watched those figures in his ledger on that desk under the head of "pounds of steam per pound of coal," and he schemed and studied how to work up from 4 to 4½ and from 4½ to 4¾.

The boss gave him a box of cigars when he got up to 5, and a suit of clothes when it touched 6.

Note: The boss could well afford it.

Returning to the engine room we may glance at some items that ought to go into the book on the engineer's desk.

*From a paper read before the Eastern Ice Association.

The Indicator Diagram

PERIODICALLY, cards from the engine and the compressor should be taken. The engineer should examine these cards to see if the valve action is all right. He should take the compressor card to his desk and draw in the adiabatic and isothermal lines. He shouldn't be afraid of these long names. He doesn't need a technical college course to show him how to draw in these lines or to show him their meaning.

Any man with common sense can do it by blindly following the plain directions of a textbook. Perhaps he might get a little help from a brother engineer. Perhaps if he hasn't got the textbook the boss might buy it for him. It will only cost a couple of dollars, and if, by analyzing the card, he finds he can get a fraction of a ton more ice per horsepower of the engine the boss is many dollars to the good.

Let the engineer figure up his horsepower on both engine and compressor, and put them down in his book under the head of "Relation of engine horsepower to compressor horsepower." Let him set down the figure that tells him either that something is wrong or all is well in the transmission between his steam and his gas. Compare these figures from time to time; see if they are up to the mark. Find out what some other bookkeeping engineer is getting for the same item. Compare it with the manufacturer's guarantee. It will interest you.

"Engine horsepower per ton of ice.

"Compressor horsepower per ton of ice."

These you will find most illuminating.

Another little item to put in this book is: "Cubic inches nominal displacement per minute per ton of ice per day."

Put that down and compare one day with another and one month's average with another. Compare it with your neighbor's. Who's doing the best, and why?

Studying the Log

OF course, a regular log of temperatures, pressures, etc., is supposed to be kept in every well-regulated engine room; but what is the use of keeping it unless the engineer studies it.

Take these items:

"Head pressure."

"Temperature of water leaving condenser."

Every day these should be compared, and if the head pressure is higher than that due to a temperature of say 3 deg. above the temperature of the outlet water, the condenser needs to be purged or cleaned, or it is too small for the work.

Every day that this pressure is higher than it should be, means more coal burned than should be burned. If this and other items are not recorded, watched and compared from day to day, how are you going to know at the end of the year just where you were hit?

Don't be fooled on the head pressures, because your pressure gage may be located below the out-take from the discharge line, and the gage line may be full of anhydrous ammonia if the temperature of the engine room is below the condensing point of the ammonia at your head pressure. Put a gage up where this hydraulic head cannot occur.

If there is a difference between the pressure shown by your back pressure gage and the pressure shown by the inlet line on your indicator, find out which is wrong. If both are right, and the gage is higher than the indicator, you are wiredrawing through your suction valve. Maybe it's the fault of the compressor design.

The Use of Thermometers

AT the last meeting of the American Society of Refrigerating Engineers, President Friedmann read a paper on the use of thermometers on the suction and discharge lines near the compressor. Refrigerating engineers should read it, and consider the advisability of putting thermometer wells on these lines.

Put the readings of thermometers down in the book and find out where you have gotten the best results.

It may take a little time, and you will have to study these thermometer records in connection with "engine horsepower per ton of ice," or "steam generated per ton of ice," or "coal burned per ton of ice."

The engine horsepower is the quickest way to get at it if you are sure your compressor is all right. It only takes a few minutes to take off a card if you are permanently rigged up for it, as you should be.

Study the Auxiliaries

AUXILIARIES ought to have a page or 2 in the book. I am somewhat of a crank on this subject, so I won't trust myself to say more than a few words on it. I think that if you will look into it you will find out some things for yourself.

If you have direct-acting pumps, figure out the amount of water they are apparently lifting, based on their displacement per minute. They are not lifting that much, but they are calling for just as much steam as if they were.

Put this into pounds. Fit a pressure gage near the discharge and find the pressure against which they are pumping.

For a rough calculation double this number of pounds, which will give you the head in feet; add to this the number of feet of suction; multiply this total number of feet by the pounds per minute, and divide by 33,000; the result will be the horsepower delivered to the water.

It is pretty safe to say that you are using 150 lb. of steam per hour for each horsepower of water. Multiply your water horsepower by 150 (or 200, if your pumps are old) and divide by your rate of evaporation to get your coal per hour; multiply this by 24 to get your cost per day, and this by your cost per pound of coal, and some of you will go up into the air further than your feet or head.

Put this down in the book; and deducting the coal charged to all your auxiliaries from the total coal you will have the coal charged to the engines driving your compressors, if you have a raw-water plant. If you have a distilled water plant, I would have a permanent way of measuring your waste from your skimmers. A meter is a good way, but a couple of barrels will do, with them alternating you can get a pretty fair idea of how much goes this way. Possibly it will look like a large item and you will try to find out a way of reducing it and still obtain good ice.

It is quite possible with a distilled water plant to set down in his book:

Coal charged to auxiliaries.

Coal charged to make up water.

Coal charged to compressor engines.

Coal charged to waste water. And then from the balance of this data to put down; approximately, "coal per low horsepower for compressor engines."

Now, as I said before, if your plant is not requiring any make up water direct from the boilers, and you have distilled water to waste, you are in a position

to cut down coal expense. Maybe your condensers are away up in the air and your water lift unnecessarily high. In any event, you can put in more efficient auxiliaries.

If you are putting in makeup steam, watch your evaporation.

If you keep shop cost books with power ratios for a season, however, I think you will conclude that in a distilled-water plant, as well as a raw-water plant, it will work out far better in the long run to put every engine you have on the best possible basis as to efficiency, and in a plant of fair size obtain your make-up water by an effective system of distillation.

Of course, I need not say that there should go into the book on the engineer's desk, in itemized form, such items as these:

Engine-room labor.
Ice handling.
Firemen and passers.
Ash removal.
Oil, waste and supplies.
Repairs.
Ammonia.

All of these items need not be enlarged upon. The cost per ton for each month should be recorded for each item.

Some Representative Figures

I HAD hoped to place before you some figures of average good practice taken from a number of plants as to the power ratios above alluded to, but I have not had time to cull all the figures I would like out of my records. A few may serve as guide posts as representing actual good, everyday figures on plants in operation making can ice at from 160 to 175 lb. head pressure and 15 to 18 lb. back pressure:

Indicated compressor horsepower per ton of ice, 1.76.

Efficiency engine to gas, 85 per cent.

Engine indicated horsepower per ton of ice, 2.02.

Horsepower on wire per ton of ice in electric-driven plant, 2.31, delivered to belt, on 88 per cent motor efficiency, 2.03; horsepower delivered from belt to gas, 85 per cent, 1.73.

Steam per ton of ice, 26 or 28 by 24 by 2.02 for engine alone, 1260 to 1375 lb. per day of 24 hr.

Waste from reboiler and skim per ton of ice, 160 lb.

Steam to drive auxiliaries per ton, 280 lb.

Steam makeup from boiler per ton, 543 lb.

Cubic inches displacement per minute per ton ice, 11,500 to 12,500.

Evaporation per pound, actual, of coal, 7.5.

Tons of ice per ton coal on 7.5 evaporation, 6.93.

These figures are not all from the same plant, but they represent good practice that is actually obtained as to each item in one or more plants, and why not work to attaining at least as good, or better practice, if possible, from every item in every plant? I suggest, also, in passing, why not put all your engines on a high plane of efficiency by operating them even in a distilled water plant on the basis of, say, 16 or 18 lb. of steam for your main engine's indicated horsepower, and say, 60 lb. of steam for your water horsepower on your pumps?

The figures above for compressor indicated horsepower and engine indicated horsepower are certainly attainable in any plant that has good compressors, and it is quite within reason to expect something like the following running condensing:

	Lb. in 24 hr.
Steam for compressor engines per ton, 18 by 24 by 2.02	873
Steam per ton for auxiliaries per ton	112
Steam for reboiler and skimmer per ton	160
Steam to be made up per ton	1175

Make up this 1175 lb. by an effect system that will give you 30 to 50 lb. of steam per pound of coal, instead of only 6 or 7 or 7.5.

If you are on a raw-water basis, the problem is simpler. Keep watch of your power factories, your evaporation, and crowd all your steam cylinders to the highest state of efficiency possible, and look out for unnecessary lifts of condensing water. Please remember I am talking about present plants, not about new ones. New installations would have to be discussed from another standpoint.

HEATING A MANUFACTURING BUILDING

How a 50 Per Cent Saving Was Effected in the Fuel Required

BY the installation of a vacuum system of steam heating in the manufacturing building, corner of Hayter and Teraulay streets, Toronto, owned by Mr. Lindsay, formerly of the Dominion Show Case Co., a saving has been effected of 50 per cent

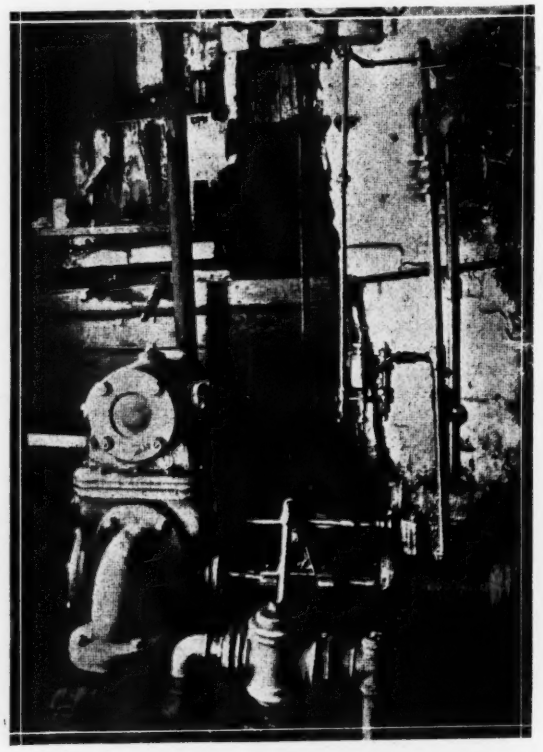


FIG. 2. VACUUM PUMP

in the fuel consumption. The building had been heated with the exhaust steam from the engine (helped out with live steam when necessary), with the ordinary system of steam piping and radiators, the steam and condensation returning by the same pipe.

By the installation of a valve, as shown at A in Fig. 1, at each of the heating coils and the radiators, which allows the condensation to flow into the return

pipe, and the installation of a vacuum pump, as shown in Fig. 2, to return this condensation to the boiler, the fuel bill was cut in half. The same piping and radiators were used, and although the piping was giving trouble before because of the pressure causing leaks, under the vacuum system, it is now giving no trouble whatever.

FIG. 1. ARRANGEMENT OF HEATING COILS AND RETURN PIPE IN A VACUUM HEATING SYSTEM

The heart of the system is, of course, the valve. This valve is so constructed that the water of condensation gathers in the bowl of the valve and lifts a float, which allows the water to flow into the return pipe,

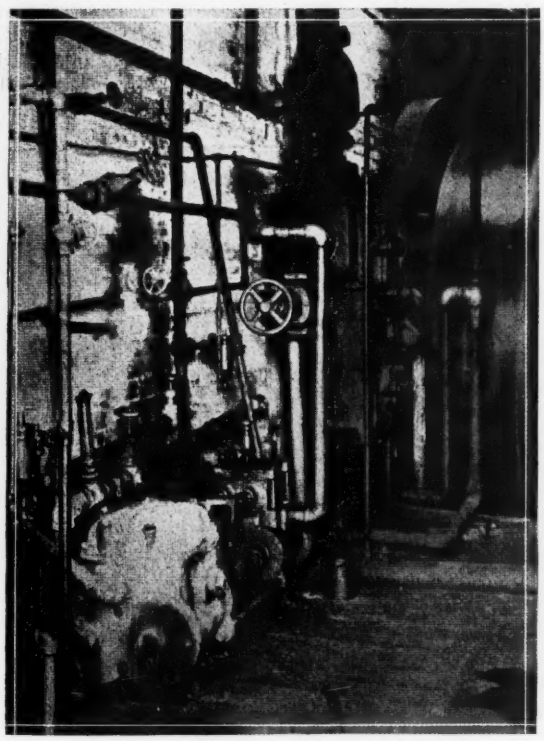


FIG. 3. CORNER OF ENGINE ROOM

from which it is taken back to the boiler by means of the vacuum pump. The sources of the great economy are the automatic draining of the heating coils and radiators of all condensation as it forms, and thus doing away with water logging; the doing away with the air binding in radiators and pipes; and the elimination of the back pressure on the engine.

In Fig. 3 is shown the boiler feed pump and a feed water heater, which was also installed when the vacuum system of heating was installed, which does its share in the saving of fuel.—The Canadian Manufacturer.

LOW FREEZING TEMPERATURE LIQUIDS

FOR engines which must be exposed to cold weather, or other location where a non-freezing liquid is wanted, the following solutions will be found useful:

Wood Alcohol and Water

Per Cent Solution	Freezing Temp.
10	+ 18 deg. F.
20	+ 5 deg. F.
25	— 2 deg. F.
30	— 9 deg. F.
35	— 15 deg. F.
40	— 24 deg. F.

Calcium Chloride and Water

Lb. per Gal.	Freezing Temp.
1	+ 27 deg. F.
2	+ 18 deg. F.
3	— 1.5 deg. F.
3.5	— 8 deg. F.
4	— 17 deg. F.
5	— 39 deg. F.

Glycerine and Water

Per Cent Solution	Freezing Temp.
10	+ 28 deg. F.
30	+ 15 deg. F.
40	+ 5 deg. F.
50	— 2 deg. F.
55	— 10 deg. F.

Glycerine 1 part, Water 1 part, Alcohol 2 parts

Per Cent Solution	Freezing Temp.
10	+ 25 deg. F.
20	+ 15 deg. F.
25	+ 8 deg. F.
30	— 5 deg. F.
35	— 15 deg. F.

With alcohol solution the alcohol will evaporate rather rapidly and must be renewed; in all other respects it is an ideal combination.

When using calcium chloride, the pure article must be secured, as impure or crude calcium is likely to corrode the metal.

Glycerine does not evaporate and will not corrode the metal but will attack rubber in hose joints or packings. If overheated, the water may boil away and must be replaced.

Combination solutions of alcohol and glycerine in water evaporate less than the alcohol solution and do not thicken as readily as the glycerine solution, besides permitting of a larger total proportion of water than either simple solution.

THE VALUE OF coal bins, made of reinforced concrete, was shown at a fire in Minneapolis recently where 224 tons of coal were stored in the bins of wholesale dealers and ignited, burning for several days and filling the building with gas, but the fire did not sperad on account of the reinforced concrete walls of the bins and the plant was saved from destruction.

OPERATING AMMOMIA COMPRESSORS*

Use of Temperatures Rather Than Gage Readings

By E. N. Friedmann

IMPORTANCE of thermometer readings is shown by the fact that manufacturers of compressors in testing for possible causes of low capacity and efficiency look more closely to temperatures than to any other condition.

Superheat of the ammonia in the suction causes a loss, one case being cited where 31 deg. F. superheat with a back pressure of 15.67 lb. caused 8.8 tons loss in capacity in a 16 by 24-in. single acting compressor.

In another case, allowing liquid ammonia to reach the compressor reducing the discharge temperature from 240 deg. to 100 deg., the loss in capacity was 14 tons.

Manipulation of Compressors with Thermometers

IT is not easy to make this manpulating of compressors with the aid of thermometers general. It requires patience and work, but it will undoubtedly come, and the sooner the better. You will agree with me that it is easy enough to detect radical defects, such as broken valves, leaky pistons on account of packing rings breaking, and cutting compressors, etc., sometimes with the aid of an indicator, sometimes without. But at best the indicator only shows whether any of the above defects exist, and whether there is any excessive clearance, and consequently re-expansion.

This, of course, gives a chance to remedy these defects, unless the general construction of the compressor prohibits it. But even if the indicator diagram does not show any plain defects, even if the compressor is in fairly good working condition, still the capacity may vary considerably according to how it is handled. It is in preventing these small continuous losses that the competent operating engineer can prove his value.

In cases where tests have been made the engineer naturally will learn a whole lot if he keeps his eyes open and is willing to learn. But in the majority of cases no test ever is made, and the compressors may be run for years under faulty conditions of operating.

Generally speaking, I believe more mistakes are made in allowing too much liquid to enter the compressor than the opposite; therefore it is important to have some kind of a guide to prevent this, since in my opinion it is less detrimental to allow a very slight superheat, than to flood the compressor. I, therefore, suggest a short table, as follows:

Gage Pressure.	Boiling Point, Degrees.	Temp. at which Suction Gas shall Enter Compressor, Degrees.
12.25	— 5	+ 3
15.67	0	+ 7
19.46	+ 5	+11
23.64	10	+16
28.24	15	+20
33.25	20	+25
38.73	25	+28
44.72	30	+33

The idea is plain. If the gage shows about 20 lb. back pressure the thermometer on suction should show about +11 deg. F., etc. This table, of course, is not perfect, but if we all get together and compare notes it should be feasible to make up a table which is nearly correct, and will at least give a man an idea how to handle his expansion to get best results.

If the suction gas is handled right the discharge will take care of itself. Since, however, I have found that the idea as to what a reasonable discharge temperature is, is very hazy in the minds of operating men who are not in the habit of making tests, I think it is necessary to give also an idea of how these temperatures usually run. From various tests the following figures suggest themselves:

Back Pressure.	Single-Acting Comp., Degrees.	Double-Acting Comp., Degrees.
5	260	300
15	240	287
25	213	253

This is assuming cooling water of an initial temperature of 60 deg. F. For higher temperatures add the difference to the above figures, and for lower temperatures deduct the difference in temperature of water. This also is only an indication as to averages, but is sufficiently correct to give a clue as to what temperatures to expect

As a matter of fact, the engineers of the manufacturers, especially of those having a test plant, are undoubtedly much more familiar with these figures than anybody else, and the object of these remarks on my part is to put it before the manufacturers to give the operating man the benefit of their findings, and enable him thereby to run his plant more scientifically and more economically. They have already done a great deal, in giving us the data obtained by them at an enormous expense, and deserve our lasting gratitude therefor. And I feel sure they will also do all in their power to help the operating man, who very seldom has access to their data, or if he has, only looks upon them as a conglomeration of figures very nice, and possibly of some interest to college professors, but having no direct bearing whatever on his particular case. Of course, they have a very direct bearing, and therefore it is necessary to establish some tables with data easily understood, so that the operating engineer will be able to run his compressor in a more rational way than is often the case now, and make himself thereby not only more valuable to his employer, but also of help to the manufacturer, so that in many cases the expenses and time of tests may be saved.

*From a paper before the American Society of Refrigerating Engineers at St. Louis.

THICKNESS OF OIL ENGINE CYLINDER WALLS

IT is interesting to note the remarks recently made by Wolcott Remington, the designer of oil engines, in regard to the proper thickness of the cylinder walls of oil engines. In his latest design, the Blanchard Oil Engine, Mr. Remington stated that he used the formula: T=bore of cylinder times maximum pressure divided by twice the tensile strength of iron used and multiplied by a factor of safety. Mr. Remington recommending from 6 to 10, depending upon the style of engine.

Taking a 10 by 10-in. oil engine of the 2-cycle Blanchard type operating under 300 lb. maximum pressure and using iron with 20,000 lb. tensile strength per square inch, T=10×300 divided by (2×20,000)=3/40 in. Using a factor of safety of 8, the reliable thickness of the cylinder walls is found to be 5/8 in. In regard to the thickness of jacket walls, as the water pressure is not considerable, they are made of a thickness which will be easily cast along with the cylinder proper. In this case it would be about 3/8 in.

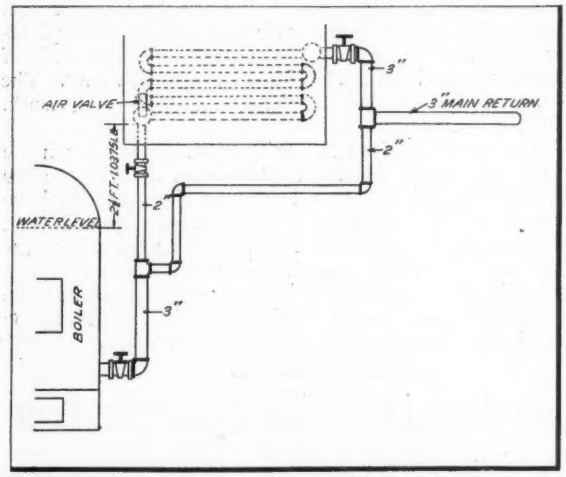
INCREASING EFFICIENCY

By Lewis A. Danner

DIRECT radiation of steam, so called, is widely used in all classes of buildings. To increase the efficiency of the heating system an indirect condensing heater is connected to it, just before the return reaches the boiler. This connection is taken off the top of the main, so that all of the condensation passes by and into the boiler, but all vapor and air in the system is passed into the indirect condensing heater, which by condensation maintains a partial vacuum on the system.

The efficiency of an indirect condensing heater depends solely in the difference of the temperature between the steam and surrounding air, and the velocity with which the air passes between the heater coils. Heaters of this form may be made of wrought iron pipe joined together with branch tees and return bends, the number of lineal feet of pipe required depending upon its size required to condense the vapor.

As the indirect heater is placed in the basement, the supply of fresh air is taken from the atmosphere through



ARRANGEMENT OF COILS AND CONNECTION FOR INCREASING HEATING EFFICIENCY

a wire screened window into galvanized iron casing and by atmospheric pressure forces the fresh air between steam heated radiator, then transmitted through ducts at a high temperature to the various rooms where heat and ventilation are required, supplementing direct radiation for heating purposes.

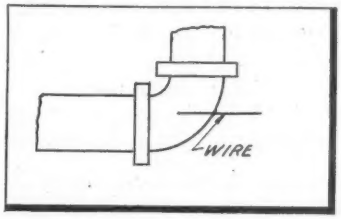
The usual method of installing the indirect heater is to place it at a sufficient elevation above the boiler so that the condensation will flow by gravity, care must be taken that the bottom of heater be of sufficient height, as the pressure of water due to its weight is equal to 0.415 lb. per square inch at 212 deg. F. for every foot in height above water-line of the boiler.

To prevent air binding in the heater, an automatic air valve of sufficient size should be located in the top of the lower branch tee to let off any accumulation of air which may be confined there under pressure and to be closed automatically after the air has been released.

HEATING SYSTEM KINK

I HAD a peculiar experience last month with the heating system, which may interest readers of Practical Engineer. The vacuum system of heating is installed in the building. The people on one of the floors complained that no heat was going up there. I sent one of the repair men to "shoot" the trouble, and he came back saying the pipe was all right. It looked as though we would have to start at the bottom and tear loose all the connections in order to locate the trouble.

After thinking it over, I decided there couldn't be anything the matter with the heat supply. Then I



METHOD OF CLEARING CLOGGED PIPE

sent the man back upstairs to try the air; there was no pressure, he said. Down below there was full pressure. The pipe above was 1¼-in., coupled off a ¾-in. pipe from below. I decided something must be wrong in this coupling. On opening it I found a gate valve clogging the pipe where it changed sizes. The small gate valve had evidently dropped in from the top somehow and, catching at the joint, had become surrounded by small particles until it formed an air-tight passage.

I find it pretty wise to watch the repair men when they start tampering with pipes.

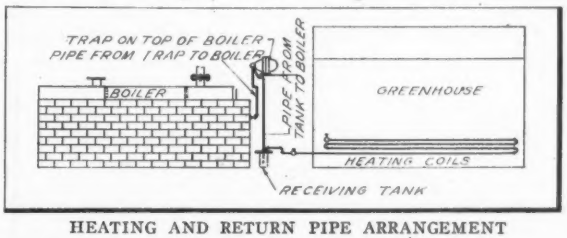
When an elbow gets clogged, I don't let them go for the big pipe wrench and tear it loose. Instead I have them bore a small hole and, by inserting a wire, dislodge whatever is caught there. A small tap can be screwed into the hole afterwards.

FEEDING THE BOILER FROM RETURNS

Use of Two Traps for Returning Condensation from Heating Coils

By H. Armstrong

ON page 105, Jan. 15 issue, in a sketch (Radiator Return Lifted 13 Feet), I fail to see anything out of the way with that, as they have a vacuum pump. Accompanying sketch shows a different proposition. I had charge of a plant that was scattered over a large area and a greenhouse was built



HEATING AND RETURN PIPE ARRANGEMENT

alongside of one of the boiler houses, on a level with the boiler room floor. The boiler was used mostly for heating, and as the buildings that were heated by this boiler were built on higher ground, the return was by gravity, but the return from the new greenhouse was a different proposition, being below the boiler. I took a large Nason trap, removed the bucket, and drilled a hole through the cover and put a pipe through the cover to about 1 in. from the bottom of the trap, which I now used as a receiving tank. This pipe I ran to a trap on top of the boiler, and from the trap I ran the discharge

to the feed pipe to the boiler; now I was all ready to heat the greenhouse, I ran all the return from the greenhouse to my home-made tank and with 10 lb. of steam or over, I had a nice working system.

H. Armstrong.

FOR WATER COOLING

FREQUENTLY the supply of water for cooling a gas engine is limited or is expensive, and it is desirable to have some means of cooling the water so that it can be used repeatedly.

In The Gas Engine, John S. Leese shows a method which he used in connection with a 30-hp. suction producer plant to replace the tanks which are sometimes used for cooling the water by natural circulation.

Five gallons of cooling water per indicated horsepower per hour were needed, and the horsepower was taken as 40 involving the use of 200 gal. of water an

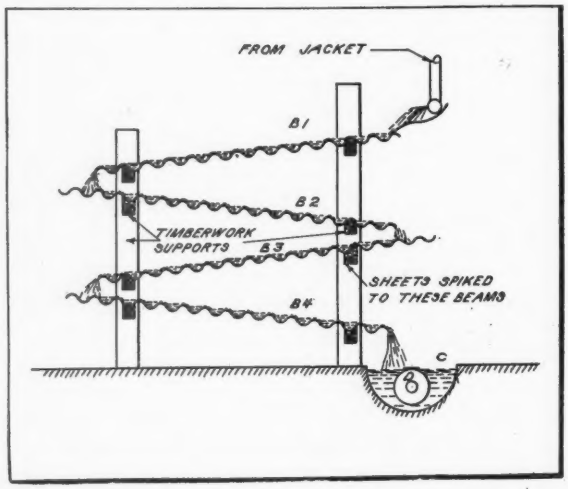


FIG. 1. COOLING PLANT FOR GAS ENGINE JACKET WATER

hour. Four old sheets of corrugated iron, each 20 by 8 ft., were secured from a junk heap and were erected as a series of inclined shelves, as indicated in the sectional view, Fig. 1. Timber work was used as supports, the jacket water being sprayed on the topmost sheet from a pipe extending the full width of the sheet and drilled with 36 1/16-in. holes equally spaced. The water runs successively over the different sheets

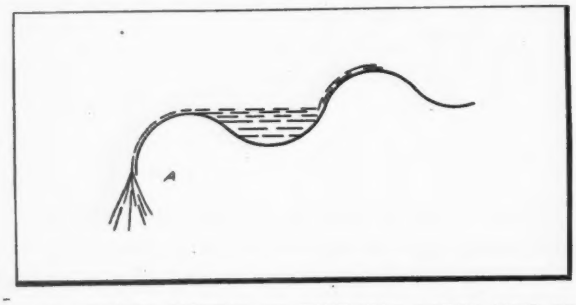


FIG. 2. PROPER METHOD OF FINISHING LOWER EDGE OF SHEET

and finally falls into a cement sump, from which it is pumped to the engine jacket.

Sheets with deep corrugations are found to be more satisfactory, as they retain the water for a longer time, and can be set at a steeper angle. The sheets are spiked to the timbers, and each spike head should be surrounded and covered with cement to prevent the water from dripping through and rotting the timbers.

At the bottom, each sheet should be finished with a corrugation convex upward, so that the water will drop off the edge without backing up on the under side of the sheet, as indicated in Fig. 2.

Mr. Leese does not state what reduction of temperature was obtained by this device, but gives the idea that the working was satisfactory.

OIL IN STEAM MAINS STOPS LEAKS

By Chas. H. Greene

IN the plant where I am employed, a 3000-hp. plant, we were troubled with many steam leaks in the mains. As there was no time to shut down for repairs, I had decided on a plan to stop them. There were about 40 leaks around the plant; today there is not a single one. Not one gasket to stop them; they are all stopped by feeding oil in the lines with 2 lubricators. One was made of an old trap, and one made of a 6-in. pipe 4 ft. long. The oil was fed in as fast as the lubricators would work. About 5 gal. every 24 hr.

The more you feed the quicker the oil will reach the joints, and mend them. It takes some time before the oil reaches all joints in a large plant, unless you have several lubricators, because the pipe gets coated first. At the present time we use 1 gal. every 24 hr. to keep the lines well coated and prevent further leaks. It took about 6 months to stop them. The first month the small leaks disappearing as the oil reached the joints and so on until before long the leaks all disappeared.

AN IMPOLITE AIR COMPRESSOR

AN incident which was ludicrous to onlookers but quite otherwise to the participants, happened when an inexperienced young engineer was on the job. We have in use an old air compressor which had punched a hole through the air cylinder head about 4 in. diameter, and this had been closed by bolting a plate over it. One day a slight leakage appeared around this plate and I said to the youngster, "John, put a new gasket under that plate when we shut down." Accordingly, at the noon hour, John took a wrench, removed the cap screws that hold the plate, and, standing directly behind the plate, started with a chisel to pry the thing loose.

Right there things happened rapidly; when John found himself he had displaced a large pane of glass in the window just behind him and was wedged in so tight that it took both of us to get him out. When he came to himself, his first remark was, "Who'd a thought that that little plate could kick so hard?"

The trouble was a valve loose, which let pressure back up from the receiver tank into the compressor cylinder, and I noticed that whenever anybody afterwards had any repairing to do on the compressor, he let pressure off the receiver before starting on the job.

Merchants' Cold Storage Co., Providence, R. I., Wilcox water tube boilers to increase their power, and are replacing 2 return tubular boilers with 2 Babcock & will be in full working in 6 weeks.

PRODUCER EFFECTS GREAT SAVING IN OPERATING COSTS

Difficulties Encountered and Overcome in Producer Gas Plants, and Items of Expense Per Month.

By George L. Markland

OUR power plant consists of a 50-hp. tandem type, suction gas producer engine with its accompanying gas producer. This equipment replaced 2 gas engines—one of 22 hp., the other of 20 hp.—which had formerly made up our power equipment, and which operated on city gas.

When our new producer plant was installed it ran well for about 6 weeks, but our man who had had no experience with producer plants adjusted the governor until the engine was running on air regulation. As the producer gas became more or less rich, the valves had to supply a proportionate quantity of air, or backfire resulted. In other words, the governor was adjusted too close to regulate properly.

After this difficulty was overcome the question of coal became a serious one. We first arranged for a supply of pea coal for which we paid $4.35 a ton. This coal clinkered badly in the producer. Consequently, we had to keep the men overtime until 7 or 8 o'clock at night to break out the clinker with sledge hammers. This kind of treatment threatened to destroy the producer, so we invited 5 different companies to send us each a ton of coal and explained to them just the conditions the coal had to meet.

One lot of coal made a beautiful fire but absolutely no gas. Another kind gave fine gas but ran into clinker as hard as flint. Finally one company suggested that we try a ton of buckwheat coal, which had given excellent satisfaction in other producer plants and which cost only $3.50 a ton. This coal we are still using, and while we have some clinker, the difficulty is slight and causes us practically no trouble. The coal is delivered to us in 15-ton lots and runs uniformly.

In the third place, we had to experiment with the time of charging the producer with coal. At first we charged the producer every 2 hours, but found that it was frequently necessary to use city gas in order to carry the engine over the period of charging. By charging the producer every 2 hours we saved stoking through the top and prevented the clinker forming. But the method proved to be impracticable, as the engine sometimes dropped its speed and stopped entirely during the time we were charging the producer.

We have found it advisable, therefore, to charge the producer at night when our factory closes and to charge it again in the morning at seven o'clock after raking the fire and poking it down.

Another practical operating difficulty which we overcame was caused by tar and other substances from the gas. This material affected the sparking points in the firing chamber and also the piston rings. We now change the sparking plugs every morning and about every 2 hours inject coal oil into the 2 cylinders and the intermediate shaft, as well as into the governor.

We have had, too, some amusing experiences, alarming at the time they happended, but always proving to be very simple after investigation.

In the first place, one of the men who erected the engine left a ½-in. nut in the governor case, and after we had been running the machine about 4 days this nut interferred with the governor balls, broke the stem and shut down the engine. After searching an hour and a half, the trouble was discovered and remedied.

A month later, after the governor had been adjusted so closely that we were depending on air regulation by valve, we got a terrific back-fire because of the bad mixture, which turned the material in the gas purifier upside down; and again the engine stopped. In this case we started the engine on city gas and later in the day discovered the trouble.

Of course, all these things affected the men in the shop so that they began to look upon the plant in the nature of an experiment; but, as anyone who reads these experiences will realize, all of the trouble came through neglect, carelessness or ignorance on the part of the gas producer operators. Our chief difficulty has been to overcome the prejudices among our employees.

The advantage of our gas producer is apparent when we compare our present fuel bills with our former cost for power. The gas engines which the present producer plant supplanted were run with commercial gas and our bills with the city gas company averaged $120.00 a month. To this we added the labor, which was about $25.00 a month. The labor cost on the present equipment is $45.00 a month, but the cost for fuel is only $30.00. In addition we charge up sixty cents worth of coal oil a month for the new plant. We later found it necessary to soak the governor cage in coal oil all night, replacing it in the morning before starting the plant; this admitted of much better regulation of speed. The other expenses incident to the power equipment are the same now as when the old equipment was in operation, with one exception; the fire insurance rate has been raised. That is to say, the underwriters have advanced our premium because of the installation of the producer plant.

As a consequence, we have an additional monthly expense of $6.50 for this item. We are making arrangements, however, to reduce the insurance item by some changes in other parts of our plant so that the insurance rate will be no higher than that which we formerly paid; and even with the higher rate which we are now paying, we are saving $62.90 per month with the producer equipment.—Factory.

FROM RECIPROCATING ENGINES TO SMALL TURBINES

ADVANCE of the small steam turbine has been remarkable. There seems to be no limit to the variety of uses to which it can be put. Statistics carefully compiled by one of the leading small turbine companies show that steam turbines are driving centrifugal pumps in over 55 different kinds of service while they are extensively used for driving generator sets, force draft blowers, gas blowers, cupola blowers, etc.

Transitions due to the small steam turbine are daily seen and one which is rather interesting is the case of the Great Atlantic & Pacific Tea Co.'s plant at Jersey City. Three years ago this plant consisted of 2 200-kw. Corliss engines direct connected to generators. To this plant was added 150-kw. Terry turbine driven generator outfit. The results were so satisfactory that in 1910 one of the 200-kw. Corliss engines made way for a 200-kw. Terry turbine driven generator set and now the other Corliss engine is being replaced by a similar steam turbine set of 300 kw. This means that at this plant in 3 yr. a complete change from reciprocating engines to small turbines will have been made.

ERECTING VERTICAL ENGINES

Methods Employed in Shop and Field

By D. J. Kelley

ERECTION of vertical engines where cranes or derricks are available does not differ materially from the erection of horizontal engines. In the field or on boats where no conveniences are at hand for lifting heavy parts the process becomes somewhat more complicated.

Bed plate shown at A in Fig. 1 is leveled with wedges and pieces of metal and the space between its

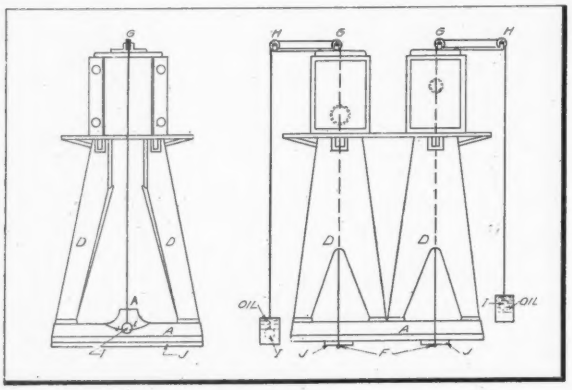


FIG. 1. METHOD OF LINING UP FRAME AND GUIDE

under side and the foundation is filled with cement or sulphur. In the shop, bed plates rest on special foundations erected for the purpose. The bearings are scraped to insure alignment. Some plants use a hollow cast iron shaft to rough scrape the bearings as it is much lighter to handle than the engine shaft. The finishing, however, should be done with the regular shaft.

Frames and guides D and D are bolted on the bed plate and doweled to secure alignment if they have to be removed. The center line of the shaft is found by placing a straight edge across the bearings on blocks covered with a piece of tin as shown at A in Fig. 1. The lines shown at F, G, H, and I, are run through the cylinders and pass over rollers at G, H. The lines are kept taut and free from vibration by a weight hanging in a dish of oil shown at I on the high- and low-pressure sides. After the lines are set the guides and cylinders are placed in position. Care should be taken to have the lines in the same plane and they should be the same distance apart top and bottom.

Sometimes the cylinders have to be raised and again they have to be planed off as occasion requires. The cylinders and guides should be clamped in place and dowel holes drilled and reamed to bring the parts in line; when once taken apart to ship, all bolt holes should be reamed and turned bolts fitted to them.

The reciprocating parts do not differ from the horizontal type of engine. The method of squaring the shaft is the same in both cases. After the engine is tested it is dismantled, the same as a horizontal engine only more of it is taken apart.

The foundation is made to suit the bed plate template, as shown in Fig. 2, which is set to line up with the engine shaft. The foundation bolts are suspended from the template, as shown in Fig. 3. The bolts should be set in pipe or pockets so that they can be moved to suit the bed plate bolt holes if not in line. The foundation bolts are made with an eye or loop at the bottom and pieces of pipe or iron 12 in. long put in to prevent the bolts from pulling up when tightening the bed down to the foundation.

LOS ANGELES AQUEDUCT HYDRO-ELECTRIC PROJECT

CITY of Los Angeles has recently approved a bond issue amounting to $357,367 to complete the equipment of the hydro-electric project to be operated in connection with the 250-mile aqueduct by which the city water is brought from Owens Lake near the Yosemite National Park. The generating equipment will be installed at Power House No. 1, located at San Franciscedo, 47 miles from Los Angeles to which point current is sent at 60,000 volts.

In the power house there will be installed 3 9375-kva., 6600-volt, 50-cycle, 3-phase water wheel generators running at 200 r.p.m.; and 2 250-kw. 250-volt direct-current water wheel generators used as exciters;

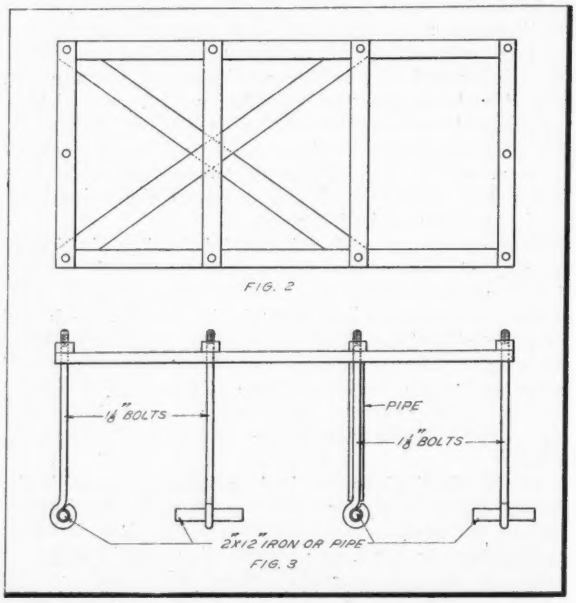


FIG. 2. PLAN OF FOUNDATION TEMPLATE
FIG. 3. METHOD OF SECURING BOLTS

10 3150-kva., single-phase, 50-cycle oil insulated water cooled transformers for raising the generator voltage, 6600, to that of the transmission, 60,000.

In the substation there will be installed 9 5000-kva., single-phase, oil insulated water cooled transformers for stepping down the transmission voltage to either 33,000 or 16,000 for secondary distribution. The contract for the entire equipment was awarded to the Westinghouse Electric & Manufacturing Company.

In its work of classifying and valuing the public coal lands the United States Geological Survey during January acted on nearly 3,000,000 acres of land which had been included in coal-land withdrawals. Of this area 2,833,306 acres were classified as noncoal land and thus restored to public entry and 240 acres were appraised as coal land. Withdrawals of coal land were also made in Utah to the extent of 57,600 acres. There remains withdrawn, awaiting classification at the present time, 69,849,861 acres.

A GAS ENGINE OPERATING HELP

Experience With a Compound Which Reduces Leakage and Labor of Upkeep and Gives Smoother Running

By L. M. Johnson

THERE is becoming quite well known in this gas engine territory a remarkable composition manufactured in Pittsburgh, which many operators of gas engines have been induced to give a trial and all seem to lead to the same results. Perhaps the writer's experience would be interesting to other readers of "Practical Engineer."

It was about two years ago a representative came into our engine room to exhibit and explain a new composition which he called Compression Paste.

This paste, he claimed, when put into a gas engine cylinder tended to improve the compression and increase efficiency if there was any leakage or blowing. The composition contained substances which tended to fill up and seal any pits or pores that might be in the walls of the cylinder or on the valve seat, and contained another ingredient which would soften and remove the carbon deposit on the cylinder head and from the piston rings so that it would pass out with the exhaust. The cylinder heads would thus be clean and smooth and the piston rings be free to fit tightly the walls of the cylinder.

Composition had the appearance of a soft, gray-colored tallow, and the representative admitted that the body of the compound was tallow coupled with other result-producing ingredients. I was rather skeptical as to the results claimed for it, but as the representative requested that we give it a trial at his expense, we readily consented. We have a plant of four 3-cylinder gas engines with a total capacity of 600 hp.

The trial was made on one of the smaller engines with a 13-in. bore and a 14-in. stroke, rated at 125 hp., which showed signs of blowing past the piston rings. Instructions for using the paste were carried out to the letter which called for the engine to be started and run until the walls of the cylinder and the piston were quite hot; then stop it, take out the igniter plugs and put the paste in on top of the piston, the heat causing it to melt quickly and flow over the surface of the piston and down to the rings.

For this size of engine four ounces of the paste were to be used in its first application, to be followed up with one or two ounces as often as once a week. The next instruction was to start the engine and run it long enough to thoroughly spread the paste on the walls of the cylinder and under the piston rings.

If the engine was needed in service it could continue to run, although later it was found that the paste could be put in when the engine was standing idle with the same results, providing the cylinders were fairly warm.

On the following day the engine was put into service on its regular turn, running through the day and the night and the second day. The third day it was shut down early in the evening and stood idle for about 12 hr.

During this first run no particular difference was noticed in the engine's performance. On the second turn the engine began to show signs of a different action. It seemed to be running with less noise than usual, and did not labor as hard as formerly.

After a week's run, and a second application of the paste, we noticed that the vapor discharge from the crank case (it was a closed type of engine), was gradually decreasing. Formerly the piston had been blowing slightly by the rings, which caused a discharge of vapor from the crank-case vent in intermittent puffs corresponding to the firing strokes of the cylinders.

Gradual cessation of the vapor discharge began to give evidence that the piston rings were becoming better fitted to the cylinders and grooves and making the cylinders tighter, thus increasing the compression.

As a result of this trial we purchased a quantity of the paste and applied the same treatment to the other engines. Each underwent the same course of improvement. Shortly before using the paste we were arranging to go over the engines, take out the pistons and clean the rings. This has usually required much hard work as the piston rings in most cases are stuck tightly in the grooves and are bedded in hard carbon deposit. We have continued the use of the paste for the past two years without removing a piston, and not one of the four engines shows sign of blowing.

Of the two 14 in. by 18 in. engines in this plant two pistons in one engine and one in the other have not been removed from the cylinders for over six and one half years, and any further idea of taking the pistons out for cleaning is not even considered.

The representative claimed also that the paste contained an ingredient which reduced or counteracted any acid effects of the oil used in the crank case when applied to it. In another gas engine plant in which I had been closely interested, the paste was tried with the same surprising results.

In this plant the paste was applied to the crank case oil, with the result that the oil had a softer and smoother feeling than when it was first used and the dried black carbon substance that usually settles in the bottom of a gas engine crank case was softened and transformed into a slimey substance. Further experiments were also tried, one of which proved to be helpful. This was to use the paste for a lubricant for the stems of the make-and-break igniters, after which the igniters would run much longer when thus lubricated, and the ground seats did not seem to wear so fast as formerly, giving longer service for the igniters before requiring adjusting.

Last summer the application of the paste was discontinued for several weeks, and one day a visitor calling at the plant made the remark that our engines were unusually noisy. We then began using the paste, and when the same visitor came into the plant several months later he remarked, "you must have been fixing up your engines lately, they do not seem to be as noisy as when I called before." This compound whatever it really contains, has evidently improved the conditions of our gas engines and I have heard of other gas engineers who have had good results from its use. This paste has recently received so much attention that one of the largest gas engine builders has been making inquiries regarding it from owners and operators of their engines.

If there are other readers who have tried it without good results, it would be interesting to know of their experience.

WATER IN STEAM PIPE

THE cause for a steam pump taking short strokes is sometimes the water in the steam pipe. By observation one will see that as soon as the pump gets dry steam it will get full stroke. That is the way my pump works. Chris. G. Chambers.

PACKING A CYLINDER HEAD

Ingenious Methods Employed for Remedying a Leak

By P. E. Merriam

SOMETIME ago the joint between the front or crank end cylinder head on the high-pressure cylinder and the frame of a compound engine began to leak. As such things grow worse the longer they continue it was decided that a corrugated copper gasket would make a good joint so the diameter of the cylinder head inside the bolt circle was taken for the outside dimension, and the bore of the cylinder as the inside diameter.

The nut on the piston was screwed back to the end of the thread, and as pressure was still applied to handle of the wrench the rod unscrewed from the crosshead and this prevented all cutting or defacing of the piston rod, which occurs when a pipe wrench is used for this work.

To avoid marring the floor the upper or finished floor boards were removed, and as the under floor was not sufficiently thick to support the weight, it was reinforced with 2-in. planks well braced from below. Two eyebolts were secured to the ceiling and a chain tackel hung from them. A stout rope was wrapped around the flange of the elbow, and a hitch made, as shown in Fig. 1, to raise the vertical pipe off the bolts and lower it to the floor. The exhaust pipe was disconnected from the cylinder flange and the next joint in the line and allowed to drop clearing the cylinder studs.

As the piston rod protruded into the frame about 18 in. when the crank was on the head end dead center, it was necessary to move the cylinder. A chisel mark was made on the frame and on the cylinder head to assist in lining up the cylinder when replaced.

Nuts on the studs which secured the cylinder and frame were given a kerosene bath and removed. The nuts were removed from the anchor bolts allowing these bolts to drop clearing the cylinder feet. A plank of suitable thickness was placed across the

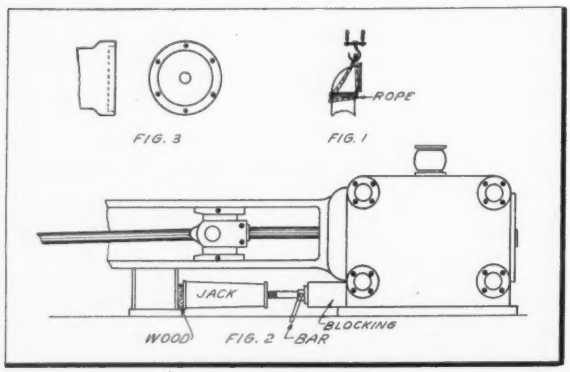


FIG. 1. METHOD OF RAISING STEAM PIPE

FIG. 2. HOW THE CYLINDER WAS REMOVED FROM THE FRAME

FIG. 3. RABBETED FRAME FOR RECEIVING CYLINDER HEAD

pedestal under the forward ends of the guides, and a jack located so that it rested on it. A block of suitable length to bear on the head of the jackscrew was then cut and another block placed across the foot of the cylinder as shown in Fig. 2. By turning the jack screw the cylinder was easily moved. An eyebolt in the ceiling over the front head supported a chain-block and tackle. The eyebolts were screwed into and through the cylinder head until they rested on the cylinder casting and acting as jackscrews forced the head away from the cylinder.

Chain tackle were then hooked on to the eyebolts and the head lowered to the floor . The surface of the head and cylinder were cleaned and given a coat of cylinder oil and graphite. The copper gasket was then inserted.

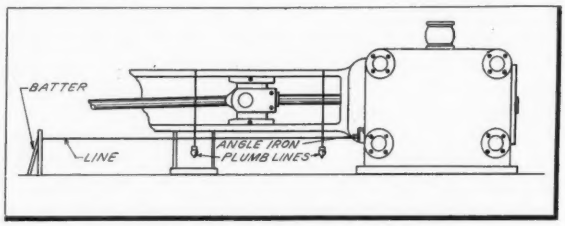


FIG. 4. LINING UP THE ENGINE

The jack was transferred to the other end of the cylinder and braced against the engine room wall. A chain tackle was secured to the cylinder to assist the jack. The cylinder was brought into place and the chisel marks on head and frame brought together. In bolting up the joint care was taken to see that no dirt was allowed to remain in the joint. The nuts were drawn up to an even bearing all around, and then given a final tightening. The steam and exhaust piping was then replaced and the anchor bolts tightened up.

Figure 3 shows a rabbeted frame. With this construction the surface against which the cylinder bears is bored out below the surface The cylinder head fits in the recess thus formed which aids in lining up the parts.

A good method for checking up after reassembling the engine, is as follows: Drop a plumb line over the frame at each end of the guides as shown in Fig. 4. Then run a level line from a support fastened to the floor to a piece of angle iron held in position by inserting it under one of the cylinder head nuts. This line should come lightly in contact with the two plumb lines and be an equal distance from two points on the crank. If these distances are not the same or the line fails to touch the plumb lines something has been thrown out of line, and the engine should be lined up a second time.

More and more are the state engineering colleges taking up the work of experimental testing with the different industries of the state. A recent example of this is at the Pennsylvania State College, where a flouring mill is now owned by the School of Engineering, and thus giving a chance for instruction in the complete operation of such a mill and also a chance for testing for improved methods of operation. Also a dynamometer car with draw bar capacity of 28,000 lb. has been placed at the disposal of the college by the Pennsylvania Railroad, and this, in connection with the 8-wheel locomotive furnished some time ago to the college by the same railroad, gives excellent equipment for experimental and instruction work.

A new feature introduced in the School of Engineering is character training, which is being given attention in all technical classes. While college courses have always been supposed to assist in character training, this is a new departure in giving actual special attention to this point, which is certainly one of the greatest important economies resuting from standardization of de-

GAS ENGINE REQUIREMENTS FOR HIGH POWER

AFTER discussing at length the difference in conditions between small and large cylinders, Charles Dawson, in the Gas Review, summarizes his conclusions as follows:

First, we will use a pretty long stroke, for this reason; in the case of a long stroke engine the diameter of the cylinder will be less for a given capacity and so the surafce of the combustion space exposed to the highest temperatures, those at the moment of explosion, will be less.

Second, the inlet and exhaust ports and valves must not be in side passages but must be in the cylinder wall so as to further reduce the surface exposed.

Third, the exhaust valve must be of the pot piston type and being set so that its lower surface is almost flush with the cylinder wall, the cooling water must be inside it and also as near to the seat as possible.

Fourth, the inlet valve must be so arranged that the incomming charge is not heated by passing through hot passages.

Fifth, there must be auxiliary exhaust ports uncovered by the piston.

Sixth, there must be a scavenger charge of cold air passed through the cylinder after each explosion and after the exhaust valve is opened so as at once to sweep out the hot exhaust gas and also cool the cylinder and piston.

Seventh, the piston itself must be water cooled on the portion exposed to the heat of explosion.

Provided these things be done there will be no trouble with engines having cylinders of 20 in. in diameter and more. Also a far higher mean effective pressure will be obtained by reason of the pure condition of the charge and a higher efficiency will be obtained because a weaker mixture can be used owing to the higher compression which can be safely carried on the one hand, and the absence of foul gas to poison the charge on the other.

Scavenging

OF all the above enumerated conditions probably the one of the most importance is the scavenger charge of cold air because this at once greatly affects the mechanical and chemical conditions. All that is necessary to provide this condition is to have a set of ports corresponding to the auxiliary exhaust ports just as in the ordinary 2 stroke engine, and to introduce the scavenger charge through them, or the mixture inlet valve can be made to serve by using secondary valves through which first plain air and then the explosive mixture is admitted.

In either case it will be necessary to provide a large supply of air at low pressure and if the passages and valves through which this air has to pass are sufficiently large it will not be necessary to employ a pressure above 4 lb. to the square inch. This pressure can be readily obtained by means of one of the many types of rotary blowers so avoiding the use of displace-pistons and valves.

In the case of an ordinary 4-stroke engine the working piston may be made to do the work by being of 2 diameters and using the annular space to act as a pump but this cannot be done in the case of an engine in which there is an explosion on both sides of the working piston and this arrangement is most desirable in engines of large power as it enables double the power to be gotten out of the same weight of metal.

In the case of large engines intended to burn heavy oil fuel it will be necessary to follow some modification of Deisel's system in order to avoid, first the deposit of tarry matter on the walls of the cylinder, and second, in order that there shall be no chance of preignition. It is by no means necessary that such high compressions as Diesel employs should be used as the air can be artificially heated by being passed through a heater on its way to the working cylinder, thereby making use of some of the waste heat from the exhaust. Suppose that the initial temperature of the air which is to be sompressed is raised to 400 degrees F; it will then only require a compression of six atmospheres to raise its temperature to 900 degrees F.

Regarding the general design and arrangement of large engines, although great success has been obtained with horizontal engines on the continent of Europe, I am inclined to facor the vertical arrangement by reason of its greater accessibility and the ease with which the water circulation can be arranged, particularly in the case of the piston and piston rods.

I would suggest that every part of the engine should be water cooled so that there shall be no chance for the accumulation of heat in any part. The lower part of the engine should be built on the well tried plan of the marine engine and the back column should be hollow so that water can be circulated through it and the base on its way to the main cylinder. I would even run water through the crank shaft as it is so much better to cool from the inside than to to pour water on the outside of the bearing, for this reason, when the shaft is first cooled it tends to shrink and so relieves the friction on the brass, whereas if the brass is first cooled it only tends to shrink the tighter on to the shaft and may so even increase the trouble rather than relieve it.

Two-Stroke Cycle Cooling

WE will now consider the 2-stroke cycle of engine in relation to large powers both the type in which the power is developed on one side of the piston only and also that in which it is developed on both. Indeed, this latter is undoubtedly the engine of the future for large powers because it exactly imitates the conditions of the steam engine—thus producing great power without any great mass and without any excessive strain on any individual parts.

This can be appreciated by the following example, the case of a single acting 4-stroke engine of say 10 by 12 in. Assuming a mean effective pressure of 80 lb. we get 190 hp., indicated at a speed of 200 r.p.m. By converting this engine into a 2-stroke and assuming the same m. e. p. we get double the horsepower or 380 without increasing the strain on any of the working parts, while bringing both sides of the piston into action on the 2-stroke cycle we again double the power which gives 760 hp. indicated from an engine having a cylinder only 10 by 12 in., so that once we can get on all fours with the steam engine the difficulty in designing engines of great power is not so very great after all, while their size will compare favorably with steam practice.

By the use of a scavenger charge of cold air, it will be possible to obtain a far higher m.e.p. Indeed, I feel pretty sure that a m.e.p. of 150 lb. can be readily obtained, in which case the gas engine will be much smaller than the steam engine of the same power, while its economy will be beyond comparison.

HEATING AND VENTILATING A LARGE BANK

Combination System with Interesting Provision for Cool and Warm Air, and Special Provision for Cleanliness.

UNION Dime Savings Bank Bldg., Sixth Ave. and 40th St., New York City, is a typical example of what can be accomplished in combining esthetic features and practical engineering details in an up-to-date commercial structure. The name of this 3 story and basement building in no way implies that it is of cheap construction as its erection together with the site, entailed an expenditure of more than 100,000 dimes or approximately $1,000,000. In its mechanical features, the building is representative of approved present day engineering practice. The interior of the banking room is of imposing proportions, 48 ft. high and measuring 96 by 86 ft. without a column or obstruction of any kind.

Interest centers about the heating and ventilating system which presents several unusual features, so devised that, with the exception of the hottest days in summer, double windows on both the avenue and street frontages can be kept closed and the interior still be supplied with an abundance of fresh air.

An institution of this kind naturally has a great number of depositors and it was the belief of the management that excellent ventilation was necessary, not only to insure the comfort of the patrons but higher efficiency on the part of the staff.

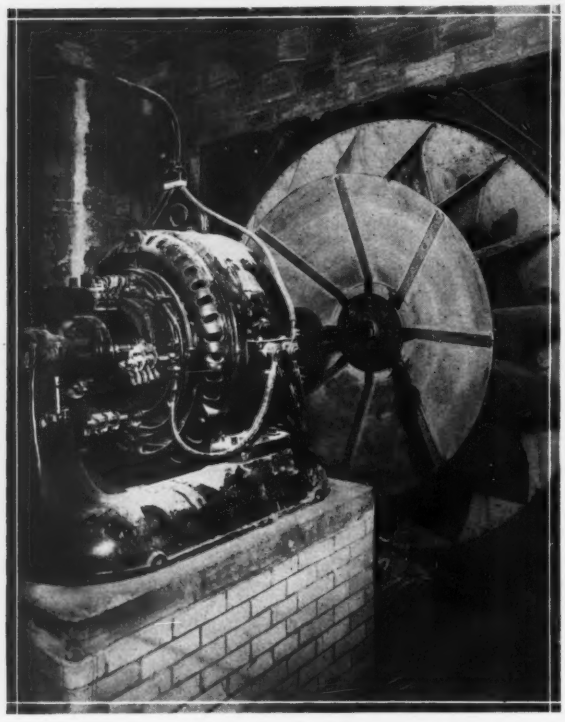


FIG. 2. MOTOR-DRIVEN VENTILATING FAN

Part of the building is subdivided into 3 floors. At the banking floor level are the president's room and the committee rooms; on the second floor the directors' room and a luncheon room; and on the third floor, the janitor's apartments.

The building is warmed by steam from 2 low-pressure cast-iron boilers, a system of direct radiation being supplied by independent steam piping from the boiler room and a group of indirect heaters being used to warm the air for ventilating the building.

One of the special features of this installation is that the warm air ducts consists throughout almost their entire length of a passage a little more than 6 ft.

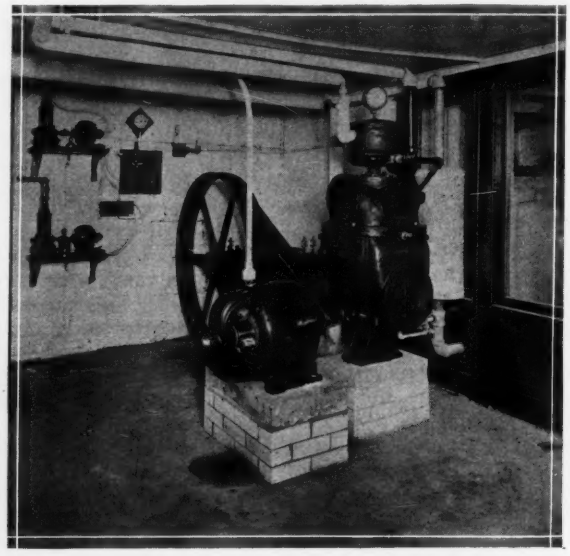


FIG. 1. VACUUM CLEANING EQUIPMENT

in height, partitioned off by a wire lath and plaster construction and located next to the outside wall of the building. The light from the basement windows reaches the basement proper by passing over the top of this passage or duct.

Air for the ventilating system is drawn from a point near the roof and is conducted into the space in front of the air filters. It then passes through special milk-straining copper wire gauze in the air filters, so arranged that they may be cleaned by means of a vacuum cleaning system shown in one of the illustrations.

When the air has passed through the air filters, it is warmed by the indirect heaters which are provided with double dampers controlled by graduated action thermostats. The apparatus is designated to warm this air to about 70 deg., after which it is forced by a 96-in. fan into the tempered air ducts.

Connections to the warm air registers consist of vertical pipes leading from the duct to the registers, so that any dust within these flues will drop into a large air passageway, which can be readily swept out. Where the duct is carried above doorways it has been made large enough so that a man can readily pass through it.

In connection with this duct or passage-way there is another feature of interest; the velocities of the air through the duct have been kept so low that when

the fan motor is doing about 2 hp. of work, the quantity of air furnished is 1,000,000 cu. ft. an hour.

In the main banking room and in certain of the other rooms, the direct radiation stands behind screens or grills. These are arranged so that they can be easily opened and the space around the radiators cleaned out. In addition, all the valves controlling these screened radiators have been placed at the basement ceiling. In the case of the radiators in the main banking room, which are arranged on the 2-pipe system, the air valves have also been placed in the basement.

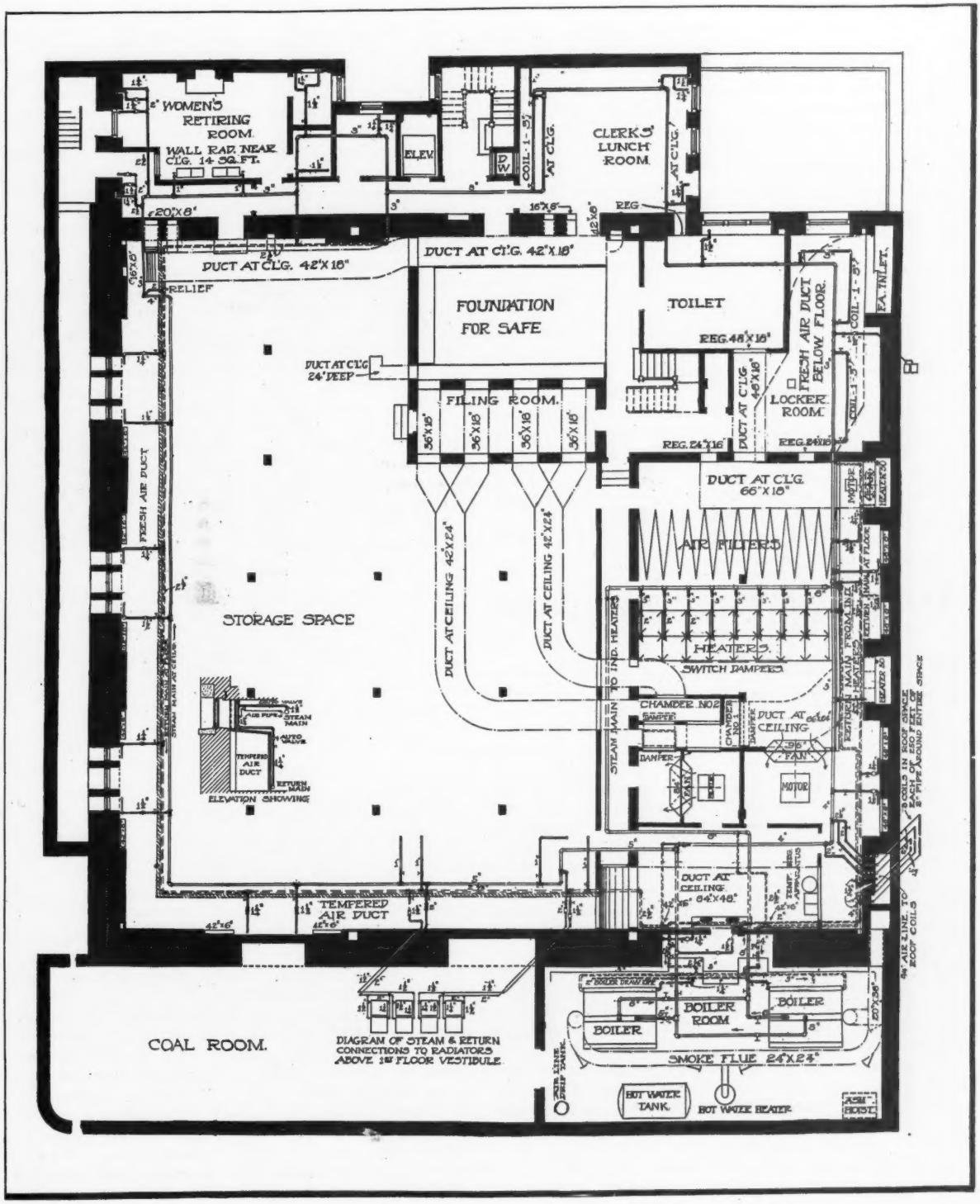


FIG. 3. PLAN OF BASEMENT SHOWING ARRANGEMENT OF HEATING AND VENTILATING SYSTEM

A ventilating fan 84 in. in diameter, is arranged to draw air in the winter through floor grills, which are located in front of the main vault, into a passageway in front of the vault foundation whence it passes through ducts to the vent fan. Papers that pass through this grill lodge in the passageway in the basement and are not drawn into the ventilating ducts, as the opening to these ducts is closed by a screen.

Ventilating ducts are located near the ceiling, and are made of such size that they can be readily cleaned. Connections at the 84-in. fan, are so arranged that it is possible to blow air into the bank instead of using the fan to exhaust the air. This is sometimes desirable in the summer. To blow air into the bank through the vent ducts in the winter will actuate a thermostatically-controlled damper on account of the drop in temperature, so that it is impossible for cold air to be blown into the bank by this fan in the winter.

Basement toilet rooms and several of the other basement rooms are ventilated by a small fan. In the ceiling of the banking room are located special outlets of large area, used in the summer to provide an outlet for the warmest air in the bank.

In the few cases in which piping is run in the tempered air duct in the basement, the pipe is first covered with pipe covering and this is encased in galvanized iron so that no dust or dirt will adhere to it.

The architect of the building is Alfred H. Taylor, New York. The heating and ventilating system was designed by William J. Baldwin and Ralph C. Taggart, New York, and the plant was installed by Gillis & Geoghegan, New York.

TRAINING THE MARINE ENGINEER

By Isaac N. Cory

THERE are many trades or professions which a young man may choose for his life work, one among the many which he may select is that of the marine engineer. There are several ways in which he may begin; the wisest course, no doubt, is an apprenticeship in an engine building shop, of 3 years. Here he learns the machinist's trade and the use of tools, and their different names; he also will help on repair work to a more or less extent, and if he keeps his eyes and ears open he will gain practical knowledge of great value.

After serving 3 years in the shop he will have to serve 12 months in the engine department of a steam vessel in commission and propelled by her own power. Or a young man may serve 36 months in the fire-room of a steamer in commission, or as an oiler, and at the expiration of either of these apprenticeships, whether machine shop or fire-room, or as an oiler, he may take his examination for a license or certificate of proficiency.

Some very interesting tales might be written regarding the experience of young men who have adopted the mechanical end of a steam vessel as their life work. The young man who makes his debut in the fire-room and gradually works his way up is usually termed a coal shovel engineer, and the young fellow who has had some machine shop experience upon starting to work in the engine room, usually receives a little more attention from the engineer, and is supposed to be a little more trustworthy; therefore his beginning is somewhat more favorable. Of course, if he is an oiler he is expected to ruin 1 or 2 squirt cans during his first few days of employment; he may also get his fingers jammed once or twice, caused, no doubt, by his being overconfident he can feel of one bearing and oil another all at the same time; this he soon finds is bad practice, and hereafter he will do one thing at a time.

The young fellow who makes his start in the fire-room is usually confident that he is able to do just as much work as the other fireman, clean just as many fires, and complete his work in the same length of time. No doubt he will receive many surprises in first handling the fire tools; he is astonished they look so light, and they prove so heavy, and quite often very hot.

When his first 4-hr. watch is over, he is so tired he cannot sleep, and he wonders if he will be able to keep on; but if he is made of the right stuff, he soon gets hardened to it, and with the exception of very hot days or nights he gets along very well.

Dust settles, so does everything else on a steamer. Coal, water, oil and grease manage to get to the bottom of a vessel or the bildges as they are called. These bildges must be cleaned and, in the iron ships, also painted. In some boats this work is a very disagreeable job; the oil sticks to your clothes, and when a new man is shipped in the fire-room and it comes the day to clean bildges, our new man is usually informed that the chief engineer has lost a five-dollar gold piece right under the main engine, and our new man is very industrious, making a thorough search for it. Needless to say, those bildges are cleaned in pretty good shape. But that is a very elusive piece of gold, in fact it is never found.

Upon completing this much-dreaded labor, our new man is perhaps told he should tidy himself up a bit, and the fireman's wash-tub is at his disposal, rubbing board and all. So he fills the tub with fresh water from the tanks, and he may then be engaged in earnest conversation by one of the other firemen, while still another knight of the coal shovel manages to dump out the fresh water from the tub and fill it with salt water. When our new man returns to his laundry work, and he begins his work of washing clothes, no soap suds appear, and it is not long before he finds he is fooled again.

He may think he is having trouble, but really he is having the best time of his life. He has no responsibility. Upon completing his watch, or time of labor, in the fire-room, he is off duty for 8 hr. He may then sleep or amuse himself in other ways in the firemen's quarters.

The watches from 4 until 8 are considered preferable. The watches are generally changed each trip, so that all may have the benefit of the most desirable watches or periods of work.

To the young man who is ambitious to become a good, all-around, practical marine engineer, many men advise that he make a change occasionally and work in different steamers during his apprenticeship period —the older the boat perhaps the better. More repairs are necessary here, as a rule. Engines require more frequent adjustment, and considerable persuasion is sometimes needed on the various pumps. Here he will gain considerable knowledge which he would not obtain on a new boat. Boiler repairs are more frequent where older boilers are in use, and where salt water may be used extensively there is a large field for observation and practical study.

Different designs of boilers and engines require different methods in their adjustment, operation and daily care. Good judgment and economy are 2 of the most

important products, as they might be called, which are demanded by agents and owners of steam vessels today.

One cannot imagine the variety of different mechanisms which are used in operating various steamers. Trained men are required, also men of good judgment and executive ability, to attend properly to the various needs and adjustments necessary for their successful operation and maintenance.

As the young man in the fire-room gets used to his work, he gains a little more confidence in himself, and if he is sober and industrious, he is also sure to gain the confidence of his chief engineer. The first assistant engineer may promote him to a knight of the squirt can and grease pail. He is then labelled an oiler and bids the coal shovel good-bye.

He now has a little more to think about, for it is necessary that he should know how each bearing is running that is under his care. He don't have so much time for spinning yarns and playing tricks, as he had in the fire-room.

After a few weeks, if he proves himself competent in this position, he may be given a chance to work the engines at the wharf, under the supervision of one of the assistant engineers. By this time he realizes that he is going up the line, and the more he learns and gains in proficiency, the more money he may be paid, for his services at this time; also, if he has neglected or been behind with his school work during his earlier life, he now understands perhaps why his parents were so anxious that he study hard at school and prepare himself for the struggle in life that comes to us all. He may study as much as he will, he will not be prepared any too well for the examination which he is to take when his apprenticeship period is completed. Examining inspectors are very particular about your test, for when you are judged competent to hold a license you may be held responsible for the lives of many people who may be passengers on the boat where you may be employed as an engineer.

If after passing the examination and receiving a license as a marine engineer, the young man begins to look about for a position, and if he is fortunate enough to obtain an assistant engineer's berth, he then begins to learn something of the responsibility and care which is attached to the marine engineer's daily work. He must be forever on the watch for defects in the machinery, pumps, boilers and automatic devices.

In the larger steamers the engineers are all given different parts of the engine and boiler rooms to look after. The chief engineer, of course, has general supervision and stands no watch, but is held responsible for the department or entire steam plant. The 1st assistant engineer hires and discharges the men below the rank of engineer. He also attends to the adjustments of the main engine. The 2nd assistant engineer may have charge of the pumps and electric generating equipment when an electrician is not employed. The 3rd assistant has charge of the boiler room, washes and cleans the boilers, and also may be responsible for small steampipe repairs and general work in the fire-room. In times of emergency or accident, the chief engineer has full control and all work is carried out under his orders.

The 3 assistant engineers stand 4-hr. watches in the engine room. This gives them 8 hr. of duty, or 16 off out of each 24. Each engineer is held responsible for the entire plant during his watch or period of duty while at sea.

All repairs are kept on record in a large book which is called the log book. This book is written up each day by the chief engineer. He also keeps an account of oil, waste, coal and many other supplies too numerous to mention. The duties of a chief engineer are many and varied. If he may be fortunate enough to hire and discharge his assistant engineers, he may have the choice of many good men, and this is a great help to him, for he may then feel more secure when he has men whom he can depend upon.

It is surprising how many men there are who hold a license of high grade who are competent in their practical work and understand the machinery under their care, but many such men are not able to maintain discipline. Their theoretical knowledge may be limited. Thus they could not fill a chief engineer's position satisfactorily. This perhaps explains why many men remain as 1st or 2nd assistants all their lives.

It is indeed interesting to note the temperament and habits of the different chief engineers with whom you may be employed. It is an old saying, and many times true, that the best engineers are eccentric men. In other words, they are hard to suit; commendation for anything you may do in your line of duty is out of the question. These men believe that if you do all you can, in the best way possible, you have only done your duty. These chief engineers are of the old school. To sail with them you will be obliged to hold your temper many times, but in the end you may be well repaid for the self-control you have exercised. A recommendation from one of these men is rarely seen; to possess one you are fortunate indeed.

Then once in a while you meet the good old fatherly chief engineer who has helped many of the younger men to promotion. He likes to see them all do well, and he is always on the lookout for promising young fellows. All the boys like him and respect him. He has a strong personality; he knows just how much he may talk with a man, and what each man is worth to him.

The young man who wishes to become a marine engineer must put up with many discomforts. He must learn to do what he is told; he must do it just as he is told to do it. He must not offer too many suggestions; he may think of many things which might be done in a different way, but if he keeps his mouth shut and watches the methods of repair work, many times his ideas will be shattered, and he will be a much wiser young man, for he has then learned by observation and has not displayed his ignorance by talking about something upon which he was not posted. He should have no conversation with his superior, unless he be spoken to, or perhaps his superior be inclined to talk, or voluntarily gives him information which he sees he is anxious to obtain.

In other words, keep your eyes and ears open, ask questions when only absolutely necessary, keep a memorandum book for reference, and attend to your own business, are some of the most valuable accomplishments attained by a good marine engineer.

WHAT IF THE GLASS SHOULD BREAK

I WAS in a boiler room one night watching the Italian fireman walking around very importantly, and asked him: "Joe, what would you do if the water glass should break?" "Go get Jim," was the answer. (Jim was a machinist). "Well, what if Jim had gone home?" "Me go home too."

C. S.

LA FRANCE GASOLINE-HYDRAULIC TRUCKS

Some Novel Features in the Application of an Old Principle to a New Use

THE American La France Fire Engine Company has developed a commercial truck embodying the invention known as the "Manly Drive," employing a simple, yet elastic and efficient, system of hydraulic transmission.

The La France truck is equipped with a gasoline engine, which is not radically different from other gasoline engines used on standard gasoline trucks. It is a 4-cylinder, 4-cycle, T-head type, with cylinders cast in pairs. The bore is 5½ in. and the stroke 6 in. It has water cooled pump circulation, and the magneto and carburettor are of accepted standard makes.

Outside of the motor, radiator, body, wheels, tires, and emergency brake, however, all the mechanism on

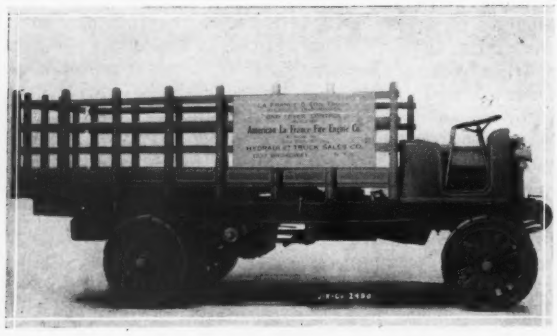


FIG. I. LA FRANCE GASOLINE-HYDRAULIC TRUCK

the ordinary truck is eliminated, and for it all a hydraulic system of power transmission is substituted. This consists of a hydraulic pump connected directly to the gasoline engine, and two hydraulic motors, one forward of each rear wheel. The hydraulic pump drives oil through the hydraulic motors, thus forcing them to turn; these motors being connected to the wheels by chains and sprockets.

The control and changing of speed is accomplished by changing the stroke of the pump. This stroke can be adjusted to anything from the thinness of a hair, up to the maximum. Any number of gradations of speed may be had from the smallest to the greatest. The greater the stroke of the pump, the greater the quantity of oil forced to the motors, and the faster the motors will run. The power of the engine being constant, decreasing the stroke, decreases the speed of the hydraulic motors, which in turn increases the turning or twisting force that these motors produce, that is, the smaller the stroke of the pump, the greater the tractive effort of the truck. So fine a stroke may be obtained as to produce almost limitless tractive effort; at least limited only to the pressure of the oil allowed by the safety valve, which is all that should ever be required in practical operation.

There are five cylinders in the pump and the same number in each motor. The cylinders are arranged radially around the crank shaft.

Figure 2 is a section through the pump showing the five cylinders. The connecting rods which drive the pistons are connected not to the pump shaft but to a bushing. The line M-N passes through the center of the pump shaft, the eccentric crank of the pump shaft and the eccentric bushing as they are shown in this sketch. The line A intersects the line M-N in the center of the pump and the center of the pump shaft. This is also the center of rotation. The pump shaft has an eccentric crank whose center is shown where the line B intersects the line M-N and the eccentric bushing has a centre when the line C intersects M-N. The eccentricity of the bushing is equal to the eccentricity of the crank. That is, the line B is equidistant from the lines A and C.

The eccentric bushing can at the will of the operator be rotated about the eccentric crank of the pump shaft independently of the rotation of the pump shaft itself. In the position shown the stroke of the pump is equal to the eccentricity of the pump crank shaft plus the eccentricity of the bushing and is the maximum. If the bushing were rotated about the crank through an angle of 180 degrees the line C would coincide with the line A, the bushing and the pump shaft thus becoming concentric and the pump would have no stroke. The different positions of the bushing between these two extremes give different strokes and since any position can be obtained, any stroke of the pump can be obtained and this of course means any speed for the truck.

The rotation of the crank bushing from the position of maximum stroke to the no-stroke point, is accomplished by the use of an auxiliary piston, lying parallel to the shaft, and supplied with power from the fluid pressure of the pump, and this piston operates on the bushing through appropriate mechanism. It is under the control of a pilot valve, which is moved at will by means of a hand lever.

The hydraulic motors are the same as the pump in every way except that their stroke is fixed and constant and equal to twice the maximum stroke of the pump. The oil used is ordinary machine oil and is used over and over again. This oil is admirably adapted to the work, because of its lubricating qualities and its freedom from any danger of freezing.

By moving the central lever between one end of its throw and the central position, the speed of the motor shaft is varied from its maximum speed to a condition of absolute rest. By moving the levers between central and the other end of its throw, the motion is reversed and any speed is secured ranging from zero to a maximum speed in the reverse direction. Meanwhile the driving shaft continues to run at constant speed, whatever the speed or direction of motion of the driven shaft, the change being in the stroke of the pistons of the pump. In this truck the maximum reverse speed is limited to one-quarter of the maximum ahead speed.

Figure 3 is an elementary sectional elevation showing the cylinders and valves of both motor and pump and the pipes connecting them. In order to make the illustration clear only one motor is shown and that is shown in line with the pump and bolted directly to it by pipes E and F. On the truck however there are two motors and the only difference is that the pipes lead oil from the pump to the motors, the oil having a little further to travel.

A represents the plungers and B the valves of the pump. Connection between the two is made by passages leading from the head ends of the pump cylinders to the centers of the corresponding valve chambers, C represents the valves and D the plungers of the motor. Here the passages between the valve cham-

bers and the plunger cylinders lead from the center of the valve chambers to the head end of the motor cylinders. The corresponding ends of the two valve chambers are connected by the pipes E and F. One pipe carries the oil in one direction, and the other pipe returns it in the opposite direcion. The outer ends of the five valve chambers of the pump are connected by the circular passage G, and the inner ends by the circular passage H; likewise the five valve chambers of the motor are connected by the circular passages I and J. For reversal, the pump stroke first passes through the zero point. Then the valves change and the oil is pumped in the opposite direction through

When the motor is going forward, pipe E furnishes a supply to the motor, transmitting the oil under pressure from pump to motor, while pipe F returns it from motor to pump, thereby answering the purpose of an exhaust pipe. When the motor goes backward, pipe F becomes the supply under pressure and pipe B changes to the exhaust pipe, the direction of circulation through the connecting pipes being completely reversed. In case of a sudden check in the speed or a quick reversal, the momentum due to running in one direction is taken up in the device itself. A safety valve, set at 2000 lbs. per square inch, opens a by-pass when there is an over-pressure and acts as a cushion preventing injury to the machine.

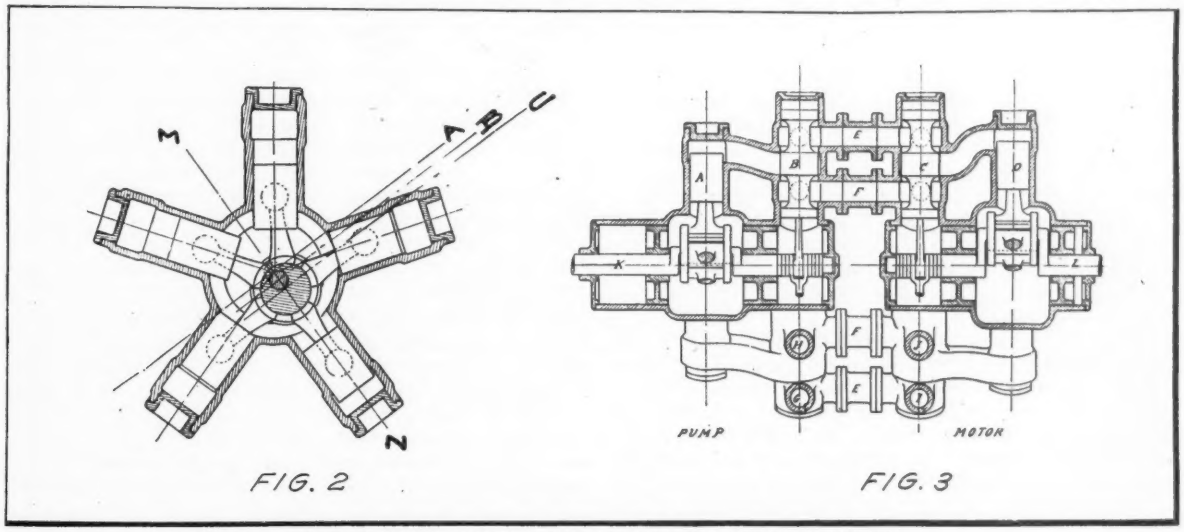


FIG. 2. MULTICYLINDERS LOCATED AROUND CENTRAL CRANK CHAMBER
FIG. 3. SECTIONAL ELEVATION OF PUMP AND MOTOR

FURNACE FOR ICE MAKING PLANTS*

Importance of Correct Design and Operation on Cost of Ice Made; Oil Burning Details

By R. H. Roark

IN operating an ice factory making distilled water ice in cans it will nearly always be found that the exhaust steam from the ice-machine engine and auxiliaries will not furnish sufficient distilled water for filling the cans, making it necessary to bleed live steam from the boilers to the condensers to supply the deficiency. This being the case, it is at once evident that the fuel economy of the plant is entirely dependent upon the economy secured in the boiler room. Here, as well as in the engine room "eternal vigilance is the price of economy," and it is not the results secured in a test run but the year around efficiency that counts when the manager holds the annual session with the directors.

To secure the greatest economy with a given fuel there are 4 important points to be observed—temperature of feed water, cleanliness of heating surfaces, design of furnace and methods of operation.

The first 2 points I shall not consider, as their importance is usually well recognized. The subject of furnace design, however, is one that does not secure the attention and study that it should, a great many people clinging to the old style construction, with an air space in the furnace walls, grates as close to the heating surfaces as possible, and a very high bridge-wall.

It has been clearly shown, both by experiment and practice, that an air space in a furnace wall does more harm than good, as it not only is poor insulation, but permits the leakage of an excess amount of air into the furnace. Grates should be so located that the hot gases will not be forced to impinge upon the heating surfaces until after combustion is completed.

This arrangement is rather difficult to obtain in some cases and the neglect of this point is the cause of the poor efficiency sometimes obtained with boilers that have the furnace enclosed within water-cooled metal surfaces, and with water-tube boilers that are so baffled that the gases are forced to pass among the tubes before combustion is completed. The bridge-wall is a necessary evil when burning coal, but should not be used when burning oil, for its only useful performance is to prevent the fuel from falling over into the combustion chamber.

In order to set fire to, or burn any kind of fuel, it is necessary, first, to supply it with sufficient air to support combustion, and, second, to raise its temper-

*Abstract of a paper before the Southwestern Ice Association.

ature to (or above) its point of ignition. Now the point of ignition of the hydrocarbon gases formed during the combustion of coal or oil is about 1,800 deg F., and if these gases are cooled much below this temperature they will not burn, and cannot burn (unless the temperature is raised sufficiently to ignite them again.) If we have, for instance, a return-tubular boiler in operation, the sheets and tubes of this boiler will have a temperature only slightly higher than that of the water and steam within the boiler, and if we permit the unburned gases to come in contact with the water-cooled sheets and tubes they will be cooled below the point of ignition, and escape up the stack unburned,

This is the great trouble in burning bituminous coal, which generates only about ¼ of its effective heat upon the grates, the balance being obtained from the combustion of the great amount of hydrocarbon gases given off by this fuel. The long flame characteristic of this fuel is permitted to impinge upon the water-cooled heating surfaces, is chilled below the point of ignition, and the unburned gases go through the tubes and up the stack, leaving behind an enormous amount of smoke and an excessive fuel bill.

In all boiler furnaces, regardless of the kind of fuel burned, there should be provided a large combustion chamber, through which the gases should pass before reaching the tubes. This combustion chamber should be paved with 2 or 3 courses of brick, laid flat, without mortar. These brick will become very hot and will greatly assist in securing more perfect combustion as they will help to keep up the temperature of the gases passing over them. The combustion chamber should be kept as clean as possible; in fact, a clean combustion chamber is almost as desirable as clean tubes, as the cleaner and hotter the combustion chamber is kept, the less soot will be formed to be deposited in the tubes.

The greatest preventable loss in boiler operation is caused, in most cases, by an excess amount of air being admitted to the furnace, and in this connection I wish to state that the efficiency of the plant, may be materially increased by keeping the furnaces well whitewashed, thus preventing the passage of air through the brickwork.

Importance of keeping the furnace walls airtight cannot be overestimated, and a careful test would show that the majority of furnace walls leak air like a sieve. This can be easily verified with an oil-burning plant. If a boiler is free from leaks and the furnace properly designed and cared for, the boiler should, after being in operation long enough for the furnace to become thoroughly heated, be able to stand-by for 12 hr. with a drop in steam pressure of not over 5 or 10 lb. This result can only be secured with a tight setting that will not permit the leakage of air, which, passing through the tubes, would cool the water and condense the steam, causing the pressure to fall.

One way of adjusting the air supply, when burning oil, is to watch the stack, and keep the air supply cut down as low as possible without causing smoke. This, while it is undoubtedly better than running with all the draft possible on, is only a makeshift for it is possible to cut down the air supply until a great deal of smoke is formed, and still have a low percentage of CO_2. This is usually caused by leakage of air into parts of the furnace where it is not needed, or by imperfect mixture of the air and gases, so that certain portions of the gases do not receive enough air while other portions receive a great deal more than is needed. A perfectly reliable hand analysis instrument may be purchased for $35 or $40, and there are very few plants, of 20 tons capacity or over, where this amount, or more, cannot be saved every month by the intelligent use of this instrument.

Another thing that pays good dividends in the boiler-room is a recording flue-gas thermometer. By its use one has an absolute record of the temperature of the flue-gases, and by a careful study of this record and an occasional flue-gas analysis can tell just what conditions give the best results. Another record that should be carefully kept is of the amount of ice drawn and of fuel used every 12 hr.

When an engineer has a record that shows the flue-gas temperature, which boilers used, name of fireman, amount of fuel used and amount of ice drawn, and will analyze the flue-gases occasionally, it does not take long to locate the cause of any sudden rise in the fuel consumption. Then, if at any time the fuel consumption varies more than it should, the engineer can instantly detect it and at once look for the cause, and this method will give a great deal better satisfaction than waiting until the fuel bill becomes so excessive that the manager becomes worried about it.

Now we come to one of the most important items about the plant, the fireman. I call him an important item for the reason that, no matter how up-to-date and well-kept the factory is, it is impossible to secure economy if the fireman, as well as the engineer, does not take an interest in securing good results. This is true regardless of the kind of fuel used, for even when burning oil or gas a careless or ignorant fireman can waste dollars mighty fast.

At the plant where I am employed Mexican firemen are used, and oil is used for fuel. The fuel consumption was lowered until the plant was making 1¼ tons ice per barrel oil, and right there it stuck, until I tried the following system. Having invested in an instrument for analyzing flue-gases, a recording flue-gas theremometer and a recording steam gage, I informed the firemen that they would be given 10 per cent of the fuel they saved over what was then being burned. This bonus was to be divided according to the excellence of the records each one made on the recording instruments and on the fuel consumption, so that the fireman who secured the best results would get the most money.

The result was all that could be desired, as far as getting the firemen interested was concerned, for they now watch their part of the plant as if their lives depended on it, and are always striving to make every saving possible. After this system was put in force the plant made a yearly average of 1½ tons per barrel oil, showing quite a decided gain in economy.

This plant uses return tubular boilers set in brick furnaces. The furnace walls are built solid, without any air space. The furnace, at grate level, is 60 in. wide, being 12 in. less than the diameter of shell (with an 18 by 72 boiler.) The sidewalls are 30 in. thick at the base, and the lining slopes outward so that they clear the shell about 4 in. at a point level with the center of the boiler, and are racked in to within ½ in. of the shell at a point level with the center of the top row of flues. The space between the shell and the brickwork at this point is filled with asbestos rope.

This sloping construction insures exceptionally long life to the lining of furnace and is worthy of careful note. The lining of an oil burning furnace is not subjected to the rough handling necessary to remove clinkers, as is the case when burning coal or lignite, but oil-fired boilers are usually operated at higher

rates of evaporation than coal burners, and the higher temperatures incident to such "crowding" must be taken care of. While this narrow firebox might be objectionable with some fuels, it is very desirable when burning oil.

The entire lining of the furnace is made of firebrick, rubbed in with a thin batter of fireclay and with every fourth course a header. The grates are of the ordinary stationary type, set with the front end about 30 in. from shell of oiler, and the rear end 10 in. lower than the front. The grates are partially covered with firebrick, leaving a strip about 12 in. wide at the front end for the admission of air. No bridge or spatter wall is used. The combustion chamber is paved with 3 layers of brick. The burner is placed in the front end, between the doors, and is so set as to throw the flame slightly downwards.

As there is nothing to cause the flame to impinge directly against the shell of the boiler there is no danger of injury to the sheets by intense local heat, even when the boiler is being forced beyond its rated capacity. And as the flame is kept away from the shell as much as possible, and as the brick in bottom of combustion chamber become incandescent when the furnace is in operation, a high temperature is maintained in the combustion chamber, a condition that is absolutely necessary to secure economical combustion. Having no checker work or spatter wall, the furnace is easily accessible, thus permitting thorough inspection of bottom of shell without removal of any brickwork.

THE INFLUENCE OF INJECTORS ON CONDENSER WORKING

THAT the maintenance of the high condenser vacuum demanded by the modern steam turbine calls for the utmost care in the design, construction, and maintenance of the condenser and piping system to provide for the absolute exclusion of air, is generally recognized. An equally important element of the plant, which is unfortunately often overlooked, is the boiler-feed apparatus. Air admitted to the boiler ultimately produces the same effect on condenser efficiency as the same amount of air admitted to any part of the steam system; but it is still quite common to find in plants otherwise designed on strictly modern lines, types of feed pumps incapable of even a moderate duty without continuous air suction. It now appears that the operation of injectors also must be carefully watched, and that the amount of air admitted to boilers fed by injectors is usually vastly underrated.

An extended series of tests made with two injectors of the ordinary single-jet automatic retarding type at the State Technical Academy in Chemnitz, Germany, is reported in recent issues of the Zeitschrift des Vereins Deutscher Ingenieure. In one experiment the quality of air admitted to the boiler with the feed water amounted to 0.49 litre per kilogramme of water, and the lowest admission reported was 0.32 litre per kilogramme. The variable condition in the tests was the adjustment of the steam spindle. These quantities, which represent atmospheric conditions, of temperature and pressure, indicate that it is possible for an injector to admit to a boiler a volume of air nearly 50 per cent, as great as the total volume of the feed water, and that with the most careful regulation of a commercial injector it is sometimes impossible to reduce the air admission below 30 per cent of the volume of the feed.

The slight vacuum maintained in the overflow pipe of an injector in operation is responsible for the suction of air past the non-return valve, which it is impossible to make absolutely air tight. In some designs of injectors, in fact, small orifices are provided in the non-return valve to facilitate the admission of air, for the purpose of providing against failure of the apparatus. For the same purpose, firemen are inclined to tamper with the valve to secure as free admission of air as possible. The design of the injector, the finish of the non-return valve, and the manner in which the apparatus is operated are, therefore, matters of considerable influence on condenser efficiency, and are worthy of careful and continuous attention.

CEMENT CONCRETE VATS AND TANKS

IMPERVIOUS, odorless, sanitary tanks can be constructed of reinforced concrete, the reinforcing to be designed by a competent engineer, provided the interior surfaces are treated as follows:

After the forms are removed, grind off with a carborundum stone any projections due to the concrete seeping through the joints between the boards. Keep the surface damp for 2 weeks from the placing of the concrete. Wash the surface thoroughly and allow to dry. Mix up a solution of 1 part water glass (sodium silicate) 40 deg. Baume, with 4 to 6 parts water, total 5 to 7 parts, according to the density of the concrete surface treated. The denser the surface the weaker should be the solution.

Apply the water glass solution with a brush. After 4 hr. and within 24 hr. wash off the surface with clear water. Again allow the surface to dry. When dry apply another coat of the water glass solution. After 4 hr. and within 24 hr. again wash off the surface with a clear water and allow to dry. Repeat this process for 3 or 4 coats, which should be sufficient to close up all the pores.

The water glass (sodium silicate) which has penetrated the pores has come in contact with the alkalies in the cement and concrete and formed into an insoluble hard material, causing the surface to become very hard to a depth of ⅛ to ½ in. according to the density of the concrete. The excess sodium silicate which has remained on the surface not having come in contact with the alkalies is soluble, therefore easily washed off with water. The reason for washing off the surface between each coat and allowing the surface to dry, is to obtain a more thorough penetration of the sodium silicate.

It is obvious that concrete surfaces so treated, if hard, impervious and insoluble, have been made impervious, odorless and sanitary.

STRENGTH WAS GREAT ASSET

YOUNG fellow with more strength than experience was working about the roundhouse. The foreman said, "Go fill boiler 22 and put a fire under her." He climbed into the cab and his eye lit on the reverse lever; that looked more like a pump than anything else, and there the foreman found him an hour later with most of his clothes off patiently working the reverse lever back and forth with an eye on the water glass. C. S.

WHERE THERE is a power plant working full time there is an industry, and where there is industry you will find the home of a busy man.

ENGINE ROOM CALCULATIONS

Steam Consumption of Pump and Engine; Engine Clearance; Boiler Shell Strength; Power of Rope Transmission; Hydraulic Power; Gain from Expansion Working of Steam

By Richard Howarth

WHAT is the steam consumption of a duplex pump 12 by 8½ by 10 in. when pumping 500 gal. of water per minute against a head, static and friction, of 110 ft.? It is well known that a duplex pump in good condition will develop 1 hp. for 100 lb. of steam per hour, running at a fair rate of speed.

As a gallon of water weighs 8.3 lb., we have 500×8.3×110÷33000=13.833, or approximately 14 hp. Assuming the pump has an efficiency of 80 per cent, 14÷80=17.5 hp., and at 100 lb. of steam per horsepower per hour the steam consumption is 17.5×100=1750 lb. of steam per hour. Of course the correctness depends on the efficiency of the pump.

Now by the slide rule, place 1 on B under 500 on A; runner to 8.3 on B; 1 on B to runner; runner to 110 on B; bring 33000 on B to the runner over 1 on B find 13.83, approximately 14 hp. Now place runner to 14 on A and bring 8 on B to runner and on A, over 1 on B find 17.5 on A; which times 100 becomes 1750 lb. of steam per hour, which is consumed by this pump.

What is the percentage of clearance in an engine cylinder 20 by 36 in. if it takes 30 lb. of water to fill the clearance space?

As there are 62.5 lb. of water to the cubic foot, the clearance volume will be found by dividing 30 by 62.5, equals 0.48 cu. ft. To get the cylinder volume, first find area by multiplying 20 by 20 and by 0.7854, which gives 314.16 sq. in., and this by 36 which gives 11,309.76 cu. in. Dividing by 1728 gives 6.54 cu. ft. as piston displacement and dividing this into 0.48, the clearance gives 0.0734 or 7.34 per cent clearance.

Now to calculate this on the slide rule, place runner to 30 on A; place 625 on B to runner, and over 1 on B find 0.48; this is cubic feet volume of clearance. To

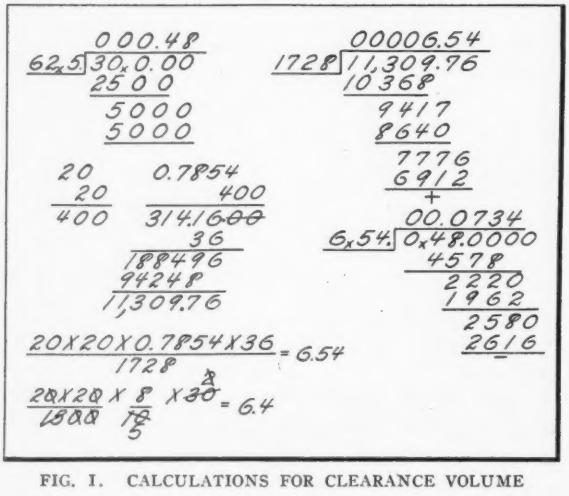


FIG. 1. CALCULATIONS FOR CLEARANCE VOLUME

get the area of a 20-in. cylinder, you will find on the right hand scale A a long thin line between 78 and 79; to this line should be set the right hand index on B, and above diameter 20 on C find 314.16 on A. Now to multiply by 36, place 1 on B under 314.16 on A runner to 36 on B; then place 1728 on B under the runner, and over 1 on B find 654 which is 6.54 cu. ft. displacement. Now place runner to 48 on A; bring 6.54 on B to runner, and over 1 on B find 7.34 which is 7.34 per cent of clearance.

What is the theoretical steam consumption of an engine 30 by 60 in.; steam pressure 100 lb., cutoff ⅓ stroke, 60 r.p.m. neglecting the clearance volume and the loss due to initial condensation? Now this calcu-

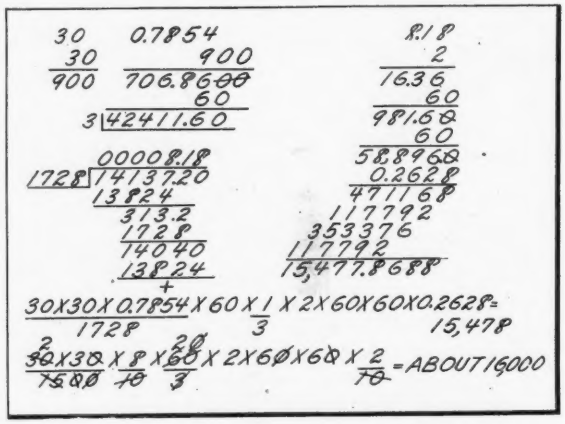


FIG. 3. CALCULATIONS FOR THEORETICAL STEAM CONSUMPTION

lation by arithmetic is 30×30×0.7854×60×⅓÷1728=8.18 cu. ft. of steam per stroke 8.18×2×60×60=58896 cu. ft. per hour. From Practical Engineer Data Sheet steam table, we find that 1 cu. ft. of steam at 100 lb. gage pressure weighs 0.2628 lb. So that 58896×0.2628=15477.9 lb. of steam consumed per hour.

Now to accomplish this calculation by use of the slide rule, the first thing is to obtain the area of the 30-in. cylinder, using the method as shown in the preceding example and get 706 sq. in.; then multiply the area by ⅓ which is the part of the stroke traveled by the piston before the valve closes, and by the stroke, 60 in.; 60×⅓=20 is solved mentally easier than by the rule; now place 1 on B under 706 on A; runner to 20 on B; place 1728 on B to runner; place runner to 2 on B; 1 on B to runner; place runner to 60 on B; bring 1 on B to the runner; bring runner to 60 on B; 1 on B to the runner; and over 0.2628 on B find 15,480 on A, which is the amount of steam consumed by this engine per hour. Now by the rule we find a difference of about 2 lb. of steam more than is shown by arithmetic; but as this is only about 0.01 of 1 per cent, it is of no account whatever in daily use.

To calculate the safe working pressure for steam boilers, the United States standard formula with a factor of safety of 6 or 1/6 the ultimate strength is; safe pressure allowed =T×t÷(R×6); in which T=tensile strength stamped on the plates, about 50,000 to 60,000 lb. per square inch of section, 6= United States factor of safety, t= thickness of plate expressed in inches, R=radius of boiler shell in inches, this is for single riveted plate and must be multiplied by the efficiency of the joint used.

As an example take a 60-in. steel boiler with plates ⅜ in.=0.375 thick, tensile strength 60,000 lb. single riveted side seams. By arithmetic we get 60,000×0.375÷(30×6)=125 lb. safe working pressure. Now if the side seams were double riveted we would have 125×1.20=150 lb. safe pressure. The calculated bursting pressure would be in the first case 125×6=750 lb. pressure per square inch.

To do these calculations on the slide rule. Place runner to 60,000 on A; 6 on B to the runner; runner to 375 on B; 30 on B to the runner; and over 1 on B find 125 safe working pressure. For the double riveted side seam, over 1.20 on B find 150 lb. on A, safe working pressure for double riveted side seams. To get the bursting pressure, let slide stand and bring runner to 6 on B and on A under runner mark find 750 lb. pressure to burst this boiler.

To show the difference of opinion of experts I will give Fairbairn's rule which allows 56 per cent of plate strength for single riveted seams, and 70 per cent for double riveted. By arithmetic 125×0.56=70 lb. per square inch safe pressure. Then for double riveted seams, 125×.70=87.5 lb. per square inch for double riveted.

How many horsepower will a 2-in. diameter hemp rope transmit at 4,000 ft. a minute? H.P.=C. A. N. S. ÷33000; in which C=a constant=100 for best hemp; A=sectional area of rope in square inches; N=number of ropes; S=speed in feet per minute. By arithmetic, 100×3×1×4000÷33000=36.36 hp.

By the rule place 1 on B to 100 on A; runner to 3 on B; 1 on B to runner; runner to 4000 on B; then place 33000 on B under the runner; and over 1 on B find 36.36 on A which is the horsepower of the rope.

How many lb. of water under a 20-ft. head would be required to develop 50 hp., assuming an efficiency of 75 per cent? By arithmetic; 50×33,000=1,650,000 ÷(20×0.75)=110,000 lb. of water a minute to develop 50 hp.

To do this on the rule, place 1 on B under 50 on A; runner to 33000 on B; 30 on B to runner; runner to 1 on B; 75 on B to runner; and over 1 on B find 110,000 lb. of water or dividing by 62.5 gives approximately 18,000 cu. ft. of water a minute.

If an engine with a piston displacement of 3 cu. ft. carries a pressure of 70 lb. per square inch throughout the stroke, suppose that steam was admitted at an initial pressure of 100 lb. per square inch with a mean forward pressure of 70 lb. per square inch; what amount of gain would be derived from working expansively?

From steam tables (Practical Reference Tables, Dec. 1911), we find that, at 70 lb. gage pressure, 1 cu. ft. of steam weighs 0.1980 lb. and 3 cu. ft., to fill the cylinder, 0.594 lb. For a mean forward pressure of 70 lb. and initial of 100 lb., the cutoff as shown by Practical Reference Tables for Mar. 1911, is ⅓ stroke, hence 1 cu. ft. of steam will fill the cylinder up to cutoff and will weigh, as shown by Practical Reference Tables for Dec. 1911, 0.2628 lb. Then 0.594—0.2628=0.3312 lb. of steam will be saved per stroke, which will be 0.3312÷0.594=0.5575 or 55.8 per cent saved.

The only use of the rule in this problem is in multiplying 0.198 by 3 to get 0.594 and in dividing 0.3312 by 0.594 to get 0.558. For the multiplication, try using C and D scales. Place 1 on C over 198 on D and under 3 on C find 594 the product. For the division, set runner to 3312 on D, and bring 594 on C to the runner; and under 1 on C find on D 558, the answer.

HISTORIC ENGINE

IN the reconstruction of the Pacific Mills power plant, a historic engine is being displaced which has more than passing interest. This is of the same type as the famous Centennial Corliss, although not so elaborately finished, and is of double walking beam construction, designed over 60 years ago. It was built in 1847, in Providence, R. I., by Nightingale, Bancroft & Co., and was one of the first engines in which Geo. H. Corliss was interested. It had 2 vertical cylinders, 30 by 84 in., both operating condensing, and ran with 30 lb. boiler pressure at 30 r. p. m., controlled by a throttling governor, as the Corliss rotary cutoff valve had not at that time been introduced. Two large condenser pumps with clapper valves on the piston and one large rubber valve for the discharge were driven directly from the walking beams, receiving water under 6-ft. head. For the last 14 years the engine has been run on low pressure steam taken from an exhaust system into which nearly 100 engines and pumps of various sizes discharged. About 350 hp. was thus generated, and this is one of the first instances recorded of the utilizing of low pressure exhaust steam for the generation of power.

In the reconstruction of the Pacific Mills plant, a central turbine plant has been installed, displacing 30,000 hp. of engines, 36,000 hp. of boilers and 7500 hp. of water wheels. The reconstruction has been designed by Chas. T. Main, and it is figured that the cost per kilowatt hour as now generated in this isolated plant is 0.841 cent.

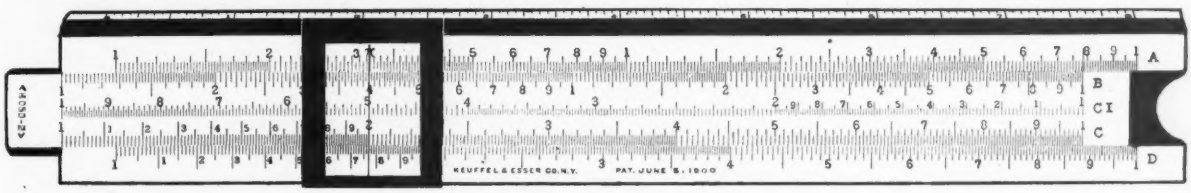
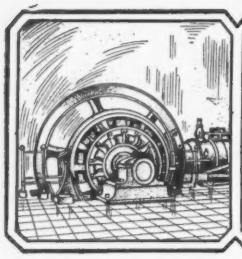


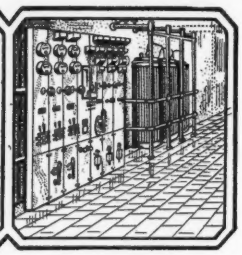
FIG. 2. SETTING OF RULE TO FIND AREA OF 20-IN. CIRCLE

THE MUCH DISCUSSED waste of natural gas is stated by the United States Geological Survey to be rapidly decreasing. The problem of conserving the natural-gas supply may be considered as having been satisfactorily solved in Pennsylvania, throughout the Appalachian and the Lima-Indiana fields, and in Kansas. The greatest waste is in Oklahoma and in the Caddo field of Louisiana, owing in Oklahoma to probable looseness in enforcement of the laws and in Louisiana to lack of a market. It is noteworthy that one of the two wild wells in Louisiana that have been sensational examples of waste have been successfully closed and the gas thus conserved for future use.



Electrical Machinery

For Generating, Transmitting and Using Current



STORAGE BATTERY PRACTICE

Purpose of a Battery Installation in Isolated Plants, Voltage Regulation, Boosters of Various Types, Auxiliary Apparatus

STORAGE batteries have a wide field of usefulness in isolated plants. In many instances they form part of the original equipment, and again they may be added at any time after the power plant has been installed. There are 4 general reasons for the installation of storage batteries: To secure continuity of service for 24 hr. without operating the generating plant during the whole period; to increase the capacity of the plant without the addition of generating units; to improve the voltage regulation; and to furnish current during a breakdown or when repairs are being made.

In small plants the auxiliary appliances used in connection with the storage battery installation are comparatively simple. Large plants, however, require somewhat more complicated machinery, depending upon the nature of the load. Where there are motor-driven elevators to be supplied with current, or other apparatus requiring a large starting torque the regulation may be so impaired as to be plainly visible in the lamps. Under such conditions a booster is generally used in connection with the batteries.

End Cell Regulation

IN all installations of a storage battery it is necessary to employ some means of regulating the e.m.f. Since the voltage of a cell varies from 1.8 volts at the end of the discharge up to 2.5 volts at the end of a charge, a number of cells in series will produce a widely varying voltage across the line unless some regulating device is provided to compensate for this voltage

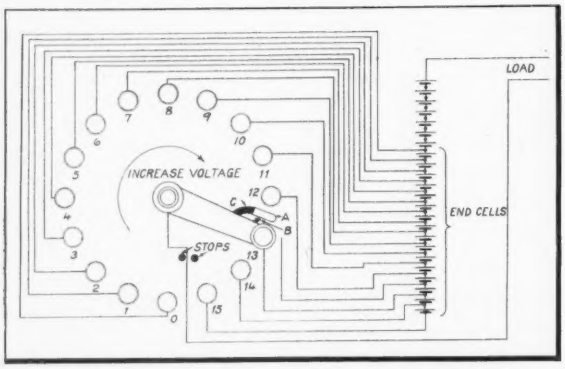


FIG. 1. CONNECTIONS OF END CELL SWITCH AND END CELLS

change. The usual method consists of varying the number of cells in series, the cells that are cut out and in being called end cells. Figure 1 shows diagramatically the arrangement of end cell connections. The switch blade makes contact with points 1, 2, 3, 4, etc. in succession, thus changing the number of cells in series across the line.

In switching from one point to the next the circuit must not be opened, neither must the blade touch 2 adjacent points as this would short circuit the cell

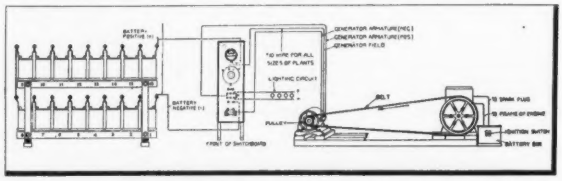


FIG. 3. CONNECTIONS OF A STORAGE BATTERY INSTALLATION USING COUNTER ELECTROMOTIVE FORCE CELLS

having its terminals connected to these points. All end cell switches are therefore provided with an auxiliary contact, either on the moving blade as shown in Fig. 1, at A, or in some instances fixed adjacent to each main contact as shown in Fig. 2. The main and auxiliary contacts are joined by a resistance, but otherwise insulated from each other. The auxiliary contact touches one of the switch points while the main contact touches the next point. The circuit is therefore not interrupted as it is completed through the resistance which has too low a value to affect the line potential appreciably. Its resistance, however, is sufficiently great to prevent short circuiting the cell connected between the 2 points.

Counter Electromotive Force Cells

INSTEAD of end cells, counter e.m.f. cells are sometimes used to maintain the line voltage constant. These cells are made of grids or other lead plates submerged in ordinary electrolyte. The plates are not formed or covered with active material and possess no capacity. Their sole function is to set up an opposing voltage to the discharge current and cut down the net voltage across the line by an amount depending upon the number of counter cells in series which oppose the e.m.f. of the main battery. As the voltage in the main battery falls, the counter cells are cut out and the external voltage of the system kept constant. The counter e.m.f. cells require the same connection to a multiple point switch as do the end cells. The complete connection of a storage battery installation, using counter e.m.f cells is shown in Fig. 3.

Large End Cell Switches

IN the larger sizes end cell switches are made straight, the movable contact traveling horizontally as shown in Fig. 4. A B and C are the contacts connected to the end cells. A′ B′ are insulated locks between the

contacts. The switch arm moves backward and forward between the guides E and E′, E′ is in the form of a rack in which a pinion meshes so that when the handle is turned motion is given to the contact. D is connected to the line. End cell switches for large plants are operated by motors controlled from the switchboard, and are also made in several forms for automatic control.

Storage Battery Boosters

A STORAGE battery booster is an auxiliary generator, generally of small size compared with the main generator. The armature is generally, though not always, connected in series with the storage battery. The voltage of this generator may be either added to or subtracted from that of the battery, thus

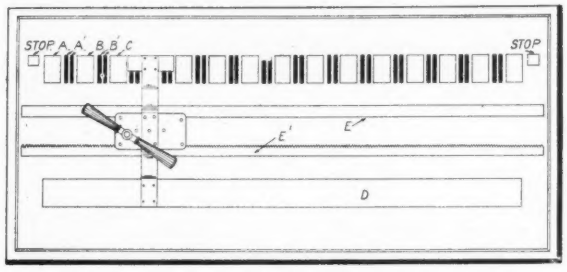


FIG. 4. TYPE OF LARGE END CELL SWITCH

increasing or decreasing its effective voltage. As an example, assume that a storage battery is working in parallel with a generator, and the armature of the booster is connected in series with the battery. Suppose, that for the present the booster is generating no voltage, and the voltage of both battery and generator is 110 volts.

Under these circumstances the battery would neither charge nor discharge.

If the field of the booster is excited so that its brush which is connected to the negative pole of the battery is positive, it is plain that the voltage generated in the booster is added to that of the battery and the electromotive force is raised above 110 volts. The battery therefore discharges, the rate of discharge depending upon the voltage generated by the booster.

If the polarity of the booster were reversed, the booster voltage would be opposed to that of the battery and the voltage would be less than 110 by the amount of the booster voltage. Looking at it in another way, the voltage of the booster is added to that of the generator so that the voltage applied to the terminals of the battery is raised above the battery voltage.

It is general practice to have the booster direct connected to a driving motor. The kilowatt capacity of the motor is less than that of the booster, for the booster never delivers its maximum current except at a low voltage, and the overcharge current is usually half the 8-hour battery rate.

Charging Booster

CONNECTIONS of a battery with a charging booster are shown in Fig. 5. The main generator field is controlled by a rheostat and its armature is connected to the line by the double-throw switch 1. The booster field controlled by a rheostat is connected across the bus bars and the booster armature is connected to the outside terminals of switch 3 which is of double-throw single-pole type. The booster and the battery are connected across the mains by the double-pole switch 2. A is an ammeter for indicating the rate of battery charge or discharge. Under the conditions shown, the booster adds its voltage to that of the generator and the combined e.m.f. is sufficient to send charge into the battery.

During discharge, switch 3 is thrown over into the opposite contact, thereby connecting the battery across the mains, when the discharge voltage can be regulated by the end cell switch. The rate of charge is controlled by the booster field rheostat.

Constant Current Boosters

CONSTANT current boosters are used in installations where there is a rapidly fluctuating load such as elevators. Figure 6 shows connections of such a booster. The effect is to cause the battery to charge or discharge automatically as the external load increases or decreases. The lighting load is connected to the mains between the main generator and the booster and battery and the motor load is connected outside of the battery as shown.

The booster is provided with both a series and a shunt winding wound in opposition. The series winding and armature are connected with the line and the shunt winding is connected to the generator busbars. The series winding of the booster produces a voltage in opposition to that of the generator, while the shunt winding acts to produce a booster voltage to assist that of the generator. The magnetomotive force produced by the booster shunt winding is greater than that produced by the series winding, therefore the booster gives a voltage in the same direction as the generator. The voltage of the power busbars is greater than that of the lighting busbars by about 15 volts which is the usual normal potential of the booster.

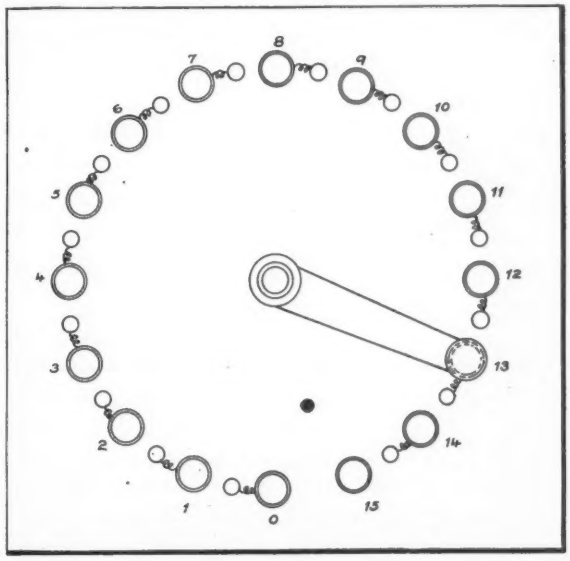


FIG. 2. END CELL SWITCH WITH AUXILIARY CONTACTS BETWEEN MAIN CONTACTS

When there is neither charge nor discharge current the bettery e.m.f. is equal to the normal e.m.f. of the power and lighting mains. The current delivered to the power busbars is the average of the fluctuating current of the motors, and its value is maintained substantially constant regardless of the load fluctuation.

When the current used by the motor is equal to the normal booster current, all current through the armature and series winding of the booster goes to the

load and the battery neither receives charge nor discharges. If the load decreases, the current through the booster armature and series winding will tend to decrease, thereby reducing the magnetization of the series winding, which strengthens the booster field. This increases the e.m.f. between the power busbars thereby sending current into the battery. By properly proportioning the field winding, the current to the

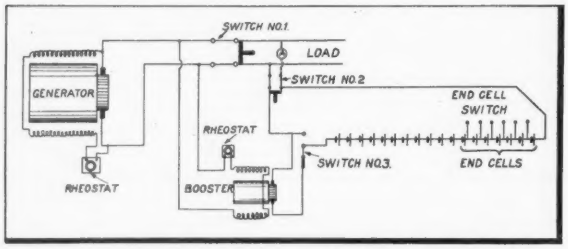


FIG. 5. CONNECTIONS OF A CHARGING BOOSTER AND BATTERIES WITH AN END CELL SWITCH

booster is reduced very slightly, the excessive current over that required for the load going to charge the battery.

If the load grows heavier, a small increase in current through the booster increases the excitation of the series winding reducing the booster e.m.f. The voltage between the lighting and power busbars is reduced and the battery discharges adding sufficient current to the constant booster current to make up the amount required for the extra load.

Differential Boosters

CONNECTIONS of a differential booster to a storage battery system are shown in Fig. 7. The armature of the booster is in series with the battery,

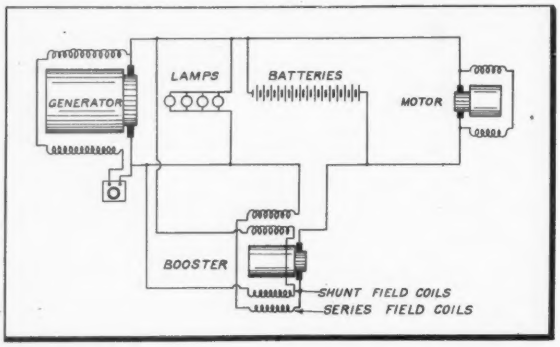


FIG. 6. CONNECTIONS OF A CONSTANT CURRENT BOOSTER SYSTEM

and the 2 are connected across the line. Under normal conditions of load, the current through the series winding produces magnetization equal to that set up by the shunt winding. The series winding tends to produce an e.m.f. opposing the generator voltage and the shunt winding tends to set up a voltage in the same direction as that of the generator. The 2 are differential in their effects, normally neutralize and the booster voltage is zero. When the external load equals the normal generator output there is no current to or from the battery. An increase above normal load tends to increase the generator output, thereby increasing the excitation of the series winding, which over powers the shunt winding and lowers the booster voltage to allow discharge from the battery.

If the load should decrease, a small diminution in the excitation of the series winding allows the shunt winding to set up a magnetization causing the booster voltage to send charge into the battery.

External Booster Control

THE external control of the booster system shown in Fig. 8, consists of an exciter which has a series field winding connected in series with the generating circuit. The booster shunt field winding is connected in series with the exciter armature winding and this circuit is connected across the line. The line potential tends to pass current through the field winding of the booster and the exciter armature winding, this tendency being opposed by the e.m.f. of the exciter armature winding. When the motor load is normal, the excitation due to normal current through the field

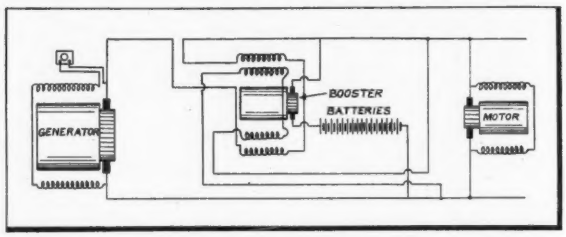


FIG. 7. CONNECTIONS OF A DIFFERENTIAL BOOSTER SYSTEM

winding of the exciter produces an exciter e.m.f. just equal and opposite to the line potential. There is no current in the booster field winding, and the booster e.m.f. is zero. With increase in load there will be a slight increase in generator current and consequently in the excitation of the exciter field winding. The exciter e.m.f. increases and being greater than the line e.m.f., establshes a current through the field winding of the booster in a direction opposite to the line e.m.f.

Excitation of the field winding of the booster produces a booster e.m.f. to discharge the battery and assists the generator to carry the load.

If the load should decrease, the excitation of the exciter field winding decreases, the voltage of the exciter falls and the line voltage being the greater, establishes a current through the field winding of the booster

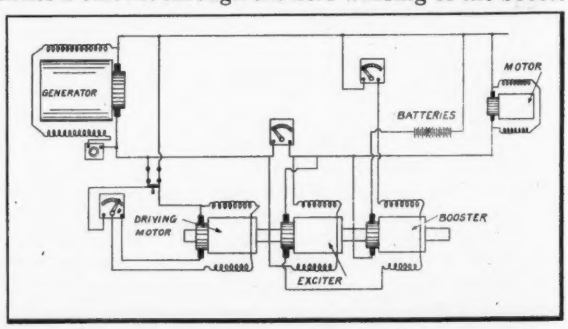


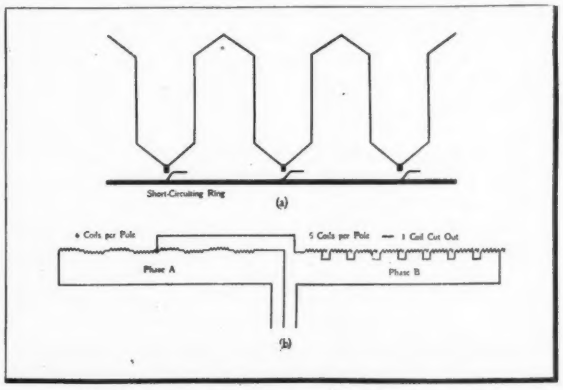
FIG. 8. EXTERNALLY CONTROLLED BOOSTER SYSTEM

and the armature winding of the exciter in a direction opposite to the exciter e.m.f. thus allowing current to flow through the booster armature to charge the battery and thereby maintaining a practically constant load on the generator. The booster rheostat controls the booster e.m.f. for a given change in the e.m.f. of the exciter. The exciter rheostat is a variable shunt which changes the proportion of generator current through its field winding. In practice the booster, exciter and driving motor are all mounted on a continuous shaft in the compact arrangement shown.

INDUCTION MOTOR WITH TWO-PHASE—THREE-PHASE CONNECTION

By D. C. McKeehan

THE difficulty arising in changing ordinary 2-phase induction motor to three-phase is that the required 3-phase voltage is usually out of range of those found in common practice. Thus, in investigating the matter of changing a certain 50-hp. induction motor from 220 v. to 440 v. 3-phase, the voltages for delta or star connection of the primary were found to be 320 and 550 respectively, while the only available supply was 440 v. The motor was of a somewhat obsolete type with revolving primary and wave-wound secondary (stator). It was started by closing the line switch and, after attaining full speed,



A. STARTING OF MOTOR AS ORIGINALLY CONNECTED
B. CHANGES OF CONNECTIONS FOR OPERATION UNDER NEW CONDITIONS

short-circuiting the stator, as shown in the accompanying illustration. The original winding consisted of 6 coils per group, each phase being connected in 2 parallel circuits of 4 groups in series, that is, 96 coils in all.

To adapt this motor for operation on the three-phase, 440 volt circuit available without altering its operating speed, the following changes were made:—In the primary phase shown at A in the figure, the 2 groups (48 coils) were connected in series, the ends being connected to the line. In phase B, the groups were connected in series, but one coil of each pole was omitted from circuit. These idle coils were left in the slots, however, in order to maintain mechanical balance of the rotor. One end of this phase was connected to the line and the other end to the middle point of phase A. The method involves no new idea, as it is simply an application of the familiar 3-phase 2-phase transformation scheme to an induction motor. The success of the arrangement meant a saving of 2 transformers besides uniformity of apparatus as regards voltage. It is applicable in cases where the two-phase motor is liberally rated, as the starting torque and maximum torque will be reduced considerably and the temperature rise at full load when operating as a three-phase motor will be about 35 per cent greater than as a two-phase machine. The motor in question had been in service for some fifteen years, and continues to operate satisfactorily with the three-phase connections.—The Electric Journal.

"BILL"

BILL was a "journeyman" fireman; that is he journeyed from place to place promiscuously. Bill claimed it was an utterly superfluous act for one to purchase a ticket from a railroad compand when one happened to feel the need of railway service for passenger transportation, provided one was not so fastidious that he was suceptible to the difference between a plush seat and the trucks or blind baggage. He further claimed this was characteristic of the ethics of the institution that enabled one to call him "journeyman," although occasionally some irresponsible person would refer to him as "Bo."

From his changing environs, Bill acquired the don't-give-a— (well, rap, is a good word to use) attitude toward all things in general. So we were not surprised to learn that one day a modest looking individual entered the boiler room of the Philphonia plant where Bill had fired for the phenomenal time of six weeks. The said modest individual nodded a pleasant good morning to Bill who, after looking the gentleman over thoroughly, returned the salutation in a very healthy voice. After an extended survey of the place, the visitor observed to Bill that the work "seemed rather hard."

"Rather hard?" returned Bill. "Well, I've fired in all kinds of boiler rooms, from the 40,000-hp. plant of the Phoney Consolidated Traction Company, to the 20-hp. plant of a Canadian saw-mill, and for hard work this job's a leader!"

"As bad as that?" questioned the visitor, whose tranquility was exasperating.

"Worse!" roared Bill; enthusiasm mounting high as the thoughts of recent troubles surged back into consciousness. "The boiler capacity's too small to begin with; the coal's rotten; aint fit for nothin'; the feed water's cold fer lack of a heater, an' everythin's on the bum.

"The chief does all he can, but I think the manager is to blame; he's tighter 'n a double-riveted joint.

"I tell you," thundered Bill, as he rose to Websterian climax, "I'd get 3 more 150 horse boiler if I was the chief if I had to choke the manager into O. K. in' the requisition."

The conversation ended abruptly and the visitor smilingly took his departure.

"Say," said Bill to the other fireman, who seemed to be unusually busy while Bill was delivering his extempore. D'ye know that guy 'twas talkin' to me while ago?"

"Know him? Well, ye didn't see me readin' poetry while he was here, did ye? Sure I know him; he's the manager."

WHO WAS CRAZY

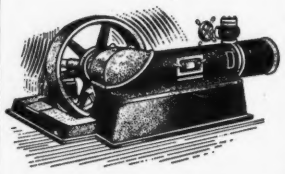
IN answer to the item entitled "Who Was Crazy?" appearing on page 70 of the January 15 issue of Practical Engineer, I should like to express the opinion that the reverse lever must have been on center and the cylinder cocks closed. There was also worn valves and the throttle leaked.

I knew of an engine, the "1322," to stand on a spur for 3 days with the throttle closed and the reverse lever in the center of the quadrant. After standing that long, she went and stood on her head in the turntable pit. No one had been near her and the track was level at that.

Chas. Sawyer.

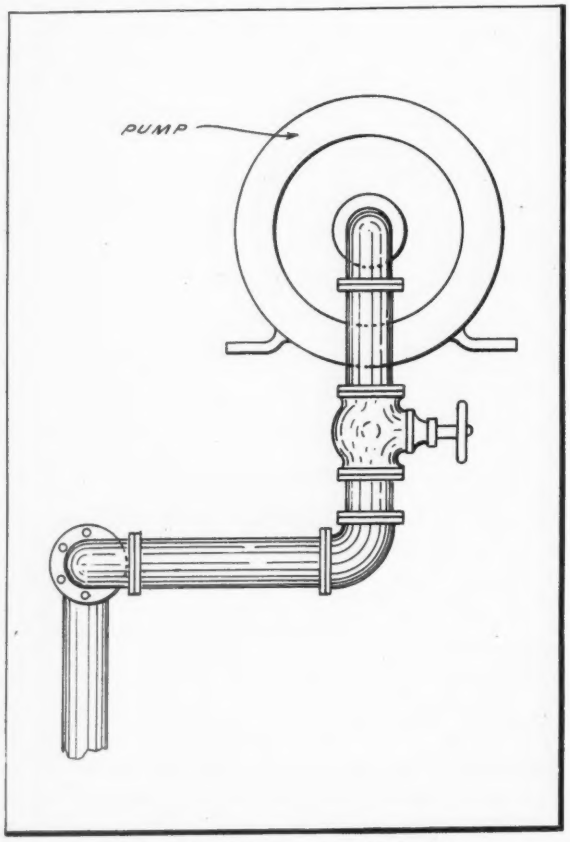
Letters from Engineers

Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



SUCTION PIPE FOR CENTRIFUGAL PUMP

MANY centrifugal pumps are very poorly installed; we find today many of these pumps being run by motors direct connected, which accounts for their general use. While the efficiency of the motor today is well up, we might say ranging from 82 to 88 per cent on moderate size motors that of the centrifugal pump is much lower, some of the smaller pumps going as high as 67 per cent, but this is a high standard and the propellers must be well designed and machined to reach such an efficiency. More of them under test would fall around 54 per cent and the common pump still lower than this; so by the aid of a motor directly connected the over all effic-



POOR SUCTION PIPE ARRANGEMENT

iency of the unit is helped out and they will handle a quantity of liquid and require small floor space the cost being small compared with any other piece of pumping apparatus.

Notwithstanding the above we can find many of the pumps installed and working just as shown in the accompanying cut. Here we have 4 short turn ells and a globe valve to pull this liquid through, which is throwing an increased load on the pump and not allowing the pump to work under conditions favorable to its construction. In this example these pumps were handling a 6-in. stream and the suction has this size and arranged just as shown, with about 14 ft. of lift and approximately 30 ft. of pipe.

Now we can imagine the saving in current on these motors by having long bends and a gate valve in place of the globe valve or by the aid of a foot valve on the suction pipe which should always be amply large for the work to be done, and again should one be compelled to use such fittings as are on this pump, they should have been not less than one size larger, this would have helped matters considerably.

The working of these pumps has always been troublesome, it is hard to get the pump to start with its lift while the most of the trouble is right in the suction line alone. The difference in current consumption would soon pay for arranging of the proper suction line.

C. R. McGahey.

COMMUTATOR SPARKING STOPPED

I HAVE a remedy for sparking commutators which gives excellent satisfaction. I had several kinds of good oil and I tried boiling the brushes in oil and also soaking them in it; and finally found the following remedy: Soak the brushes in one quart of neats foot oil for 24 hr. and then let them drip for 4 hr. After this is done, fit them very snugly to the commutator. Watch for a gummy dirt which collects on the commutator after running ¼ to ½ hr; after this is wiped off you will have no more sparking. The commutator will become a rich color after a week or so of running.

Carl C. L. Hansen.

THAT LICENSE QUESTION

LATELY there has been quite a good deal said in the magazine about license laws. There may be some injustice; that I cannot say. But how some men get licenses is a puzzle to me.

Working near me was a man with a second class license. This man was running a plant of three boilers, and one day his boiler feed pump began to short stroke because the packing in the gland on the valve stem needed tightening. He hurried to find the foreman and told him he needed another man for a while.

For nearly half a day he had the man sit beside the pump and hold the valve stem steady with his hand; then the boss came along and saw what was going on and tightened the gland himself. When the packing wore out on the water end of the piston, he quit the job because he couldn't fix it. Said the pump was ruined.

C. S.

PROPER LOCATION of the power plant whether for isolated or central station is as important as proper selection of machinery.

CHANGING ENGINE SPEED

RELATIVE to my article on steam engine governors in the January 1 issue there is one statement under the above heading criticised by Mr. Mason and needs explanation. I refer to methods therein mentioned for changing the speed of an engine that is equipped with a fly-ball governor. Theoretically there is but one way in which this can be accomplished, viz., by changing the diameter of the governor pulley, or gear wheels as the case may be, and instructions are given in the article as to the proper course to pursue in order to effect the desired change, whether it be to increase the speed of the engine, or to decrease it. The second method mentioned in the aforesaid article, viz., that of changing the weight of the balls is not to be commended; although not a few instances have been known in which the speed of an engine has been increased by adding to the weight of the balls. Still this is but a makeshift method at best, and the results obtained thereby are far from satisfactory. The illustration may serve to illustrate the principle involved in this method of changing the speed.

There are 2 forces to be considered. First, the force of gravity represented by (a) the weight of the balls, (b) the center weight C, which is hollow in some types of governors in order that shot may be put into it, or taken out as desired, (c) the movable weight B, and (d) the weights at A supported on a rod which is simply an extension of the spindle which carries C.

Second, the centrifugal force caused by the rotation of the balls around a fixed center. With a given amount of weight tending to keep the balls from rising, there will be a fixed point, or working plane in their rotation where the 2 forces will be equal, and when by centrifugal force the balls are caused to rise to that plane, the governor mechanism will be in operation, and the engine will be running at a fixed speed. But, suppose we add more weight at A, or C, or move weight B toward the end of the lever, the effect will be practically the same as if we had increased the weight of the balls, and the result will be that the force of gravity will overcome the centrifugal force to the extent, that the working plane of the balls will be changed to a lower point, and the speed of the engine and governor will be increased.

On the other hand if the weights are made lighter, the effect will be the same as if the weight of the balls had been decreased, the result being that the centrifugal force will now change the working plane of the balls to a higher point and the speed of both engine and governor will be increased. The range in which the speed of the engine may be changed by this method is limited however to a few revolutions either way, and as stated before, the method itself is not commendable, as it is not founded on desirable principles, and is liable to bring objectionable features into the operation of the engine, one of which would be to impair the sensitiveness of the governor.

C. F. Swingle.

WITH reference to Mr. Mason's article in Feb. 15 issue under the above heading, I fail to understand why any one can say even theoretically, that changing the weight of the balls on a pendulum governor will not alter the speed of the engine. Yet all the authors whom I have read tell us it is a theoretical fact.

Being the author of the letter which Mr. Mason mentions I wish to explain how the actual test came about, together with all the facts concerning it.

The question came up in the course of our educational work being conducted by Hamilton Association No. 4, N. A. S. E. and created so much discussion and differences of opinion that the writer decided to make an actual test, as no information seemed to be at hand from any one who was competent to speak from that standpoint.

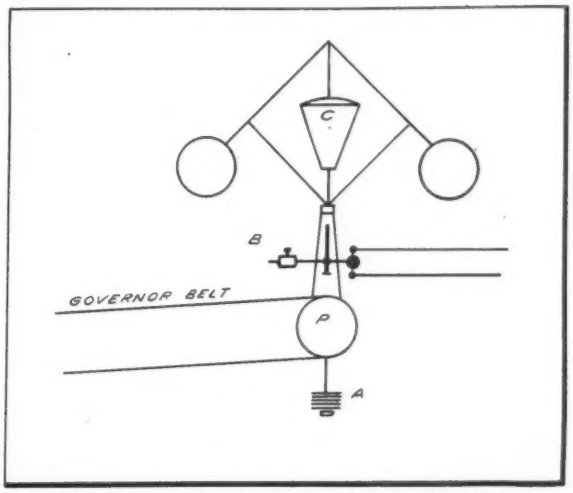


DIAGRAM SHOWIHG WEIGHTING OF GOVERNOR

Accordingly a small governor was constructed (I lay no claim to its perfection in either design or workmanship) and connected by belt to an engine driving a direct connected fan. The engine was regulated by the throttle, and as the steam pressure was constant there was a constant speed of the engine. The weight of the heaviest set of balls used was 1 lb. each, the lightest set weighed 1/5 lb. each while the weight of the parts attached to the revolving arms on which the balls were fastened, was 1½ lb.

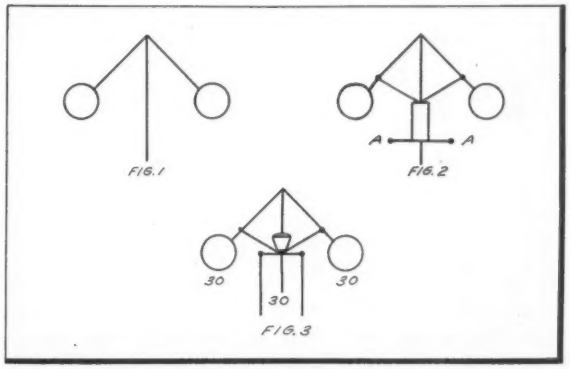


FIG. I. FLY BALLS ON PLAIN ARMS
FIG. 2. FLY BALLS WITH LIFTING ARMS, COLLAR ETC.
FIG. 3. GOVERNOR WITH COUNTERPOISE

First a test was made with nothing but the balls attached to the arms as in Fig. 1, and it was found that each set of balls revolved in the same plane regardless of the weight but according to speed. Next the lifting arms, sliding collar, etc., were attached as shown in Fig. 2, the weight of which was 1½ lb. as stated above. Then with the engine running at a speed of 81 r.p.m. the height to which the sliding collar rose was marked. The heavy set of balls was then substituted for the lighter and in order to cause the collar to stand at the same point, the engine had to be slowed down to 60 r.p.m.

Then 3 lb. of dead weight, or counterpoise, was attached to the sliding collar at A, A, Fig. 2. When

the collar stood at the above mentioned mark, the engine ran at 71 r.p.m. when using the heavy balls. The lighter balls were then placed on and the engine had to be speeded up to 129 r.p.m. in order to cause the same height of the collar.

Of course, had the governor been attached to the engine in the regulation way it would have had to be slowed down or speeded up the engine itself, which might have caused some difference in the results, but it could have been only slight.

Realizing that the imperfections in design and workmanship of the small governor might have made the test inaccurate led to the test on a Corliss engine driving a paper machine. The usual speed of the engine was 86 r.p.m., with the balls regularly used on it, they weighing 45 lb. each.

A pair of balls weighing 35 lb. each from another engine was put on and caused the engine to run at a speed of 90 r.p.m., the load being constant and exactly the same in both cases.

This governor had no counterpoise, or dead weight other than the lower set of arms, sliding collar, etc., usually found with this type of governor.

The weight of these parts was not known, but they were far lighter in proportion to the balls than were the same parts of the small governor, hence it caused a less change in the speed of the engine. .

Thus when replacing lighter balls with heavier ones the engine will slow down, and the heavier the dead weight or counterpoise the more will be the reduction in speed. In the first test the counterpoise weighed 1½ lb., and the heavy balls caused a decrease of 26 per cent in the speed of the engine, and when the counterpoise was increased to 4 lb. the decrease in speed was 45 per cent when using the heavy balls.

In the case of the governor on the engine the counterpoise or dead weight was small compared to the weight of the balls and combined with the comparatively small increase in weight of the balls (when compared to the difference in weight of those of the small governor) caused a reduction in speed of only 4½ per cent when the heavy ones were put on.

My conclusions are that the less dead weight the governor is compelled to carry the less will be the change in speed of the engine when the weight of the balls are changed, but the engine will always slow down when the weight of the balls is increased, other parts of the governor remaining the same.

Suppose the balls to weigh 30 lb. each, the counterpoise and all parts the balls are compelled to lift weigh 30 lb. also, as in Fig. 3. Then when the governor balls are revolving in their proper plane and will go no higher nor lower the centrifugal force must equal 30 +30+30=90 lb. in order to lift their own weight and the dead weight of 30 lb. attached to their arms. We therefore have a downward pull of 90 lb. due to gravity and an upward pull of 90 lb. due to centrifugal force, and as long as they remain equal the balls will revolve in the same plane. Now imagine that while running this way the balls suddenly increase in weight to 60 lb. each, the other parts remaining the same. Then according to the rule doubling the weight also doubles the centrifugal force, there will then be an upward pull of 90×2=180 lb., while the downward pull due to gravity has been increased to 60+60+30= 150 lb. This leaves an excess of 30 lb. of centrifugal force and the balls will rise to a higher plane, and in turn gives a shorter cutoff thus reducing the speed of the engine.

With balls revolving free the changing of their weight does not change their plane of rotation, but when we attach the other necessary parts of the governor the question then becomes entirely different. As to the governor not regulating so well after the balls have been changed, I think that is a mistake, so long as they are heavy enough to prevent being disturbed by the action of the knockoff mechanism, which requires but a small amount of force if properly adjusted. The governor that was tested as spoken of before seemed to regulate as well with one set of balls as the other.

The test on the regulation governor in this article was made by a member of the Educational Committee in our local Association No. 4, and was witnessed by a number of engineers the writer included, and there is no question that placing heavier balls on this type of governor will reduce the speed of the engine, other parts of the governor remaining the same.

Jos. Stewart.

IN Practical Engineer of Feb. 15, on page 230, Charles J. Mason asks under the heading of Changing Engine Speed, what other readers think about Mr. Swingle's article in the Jan. 1st issue.

I am not sure what the theory of the governor is in regard to weight and speed but it seems reasonable to suppose that an increase in weight would require an increase in speed to put the weights back in the same position. As I have had a few years experience in an electric lighting plant I know from experience that changing the weights on an engine governor will change the speed of an engine but at the same time I could not tell just what weight would produce a given speed. I know that if you have alternating current machines to synchronize you must change the speed of the engine some way to get it in step with the one which is running. The way we used to do when we were synchronizing by an incandescent lamp was to put small weights on the counterpoise, and sometimes we would get too many on and have to take some off again, usually we would get them sychronized by using from 1 to 4 small weights everything depending on the conditions.

John Mitchell.

CARDS FROM PUMPING ENGINE

W. P. F. shows a set of cards (reproduced herewith) from a Holly Gaskill type of pump for criticism.

I think Mr. F. has the eccentric too far ahead for this type of engine. Then to make the valve setting all right he had to lengthen the valve rods, and this has reduced the opening of the valves.

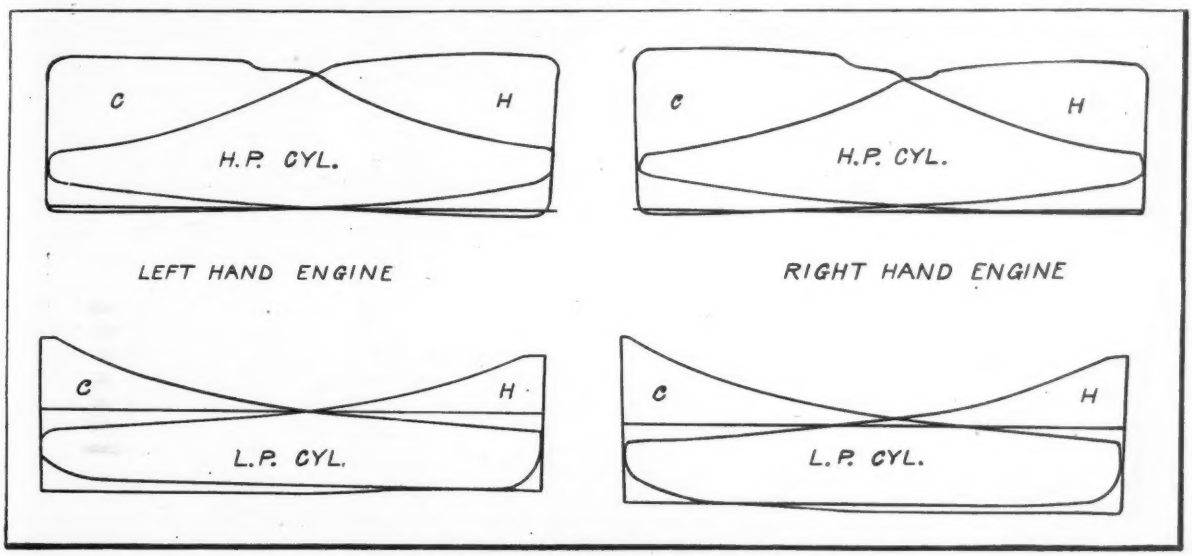
Now, because of the high steam pressure and the slow piston speed, this defect does not show in the cards until the low-pressure exhaust valves open. Then because of the large volume of steam that has to pass through the restricted port opening, the pressure does not drop at once to the condenser pressure, as it should, but drops slowly as the piston starts on the return stroke.

It is very easy to make the mistake of setting the eccentric too far ahead on this engine; because the eccentric rod does not lie along a line parallel to the center line of the shaft and high-pressure cylinder, but drops to the rocker at an angle of 10 or 12 degrees.

This has the effect of making the position of the eccentric nearer to the crank than it would be with an ordinary straight line gear, by a number of degrees equal to the angle the eccentric rod makes with the center line of the shaft and high-pressure cylinder.

The cutoff is rather late for the low working head and high steam pressure.

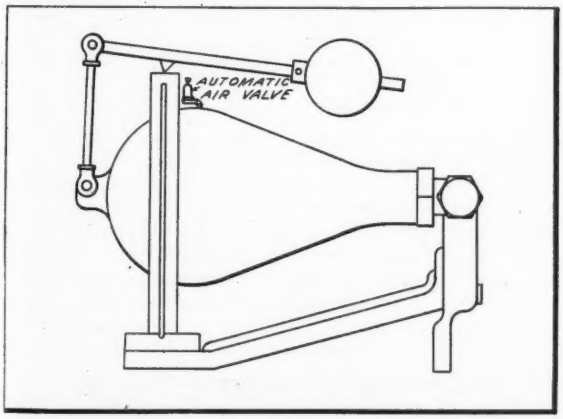
The large drop, when the intermediate valve opens, in the terminal pressure of the high-pressure cards and the short horizontal line at the beginning of the steam



SET OF CARDS FROM PUMPING ENGINE

line in the low-pressure cards indicate that the low-pressure exhaust valves are blowing.

In the cards shown in January 1st issue, the high steam line in the low-pressure card from head end is caused by a leaking steam valve in the head end of the high-pressure cylinder. The exhaust line of the high-pressure card from head end, taken at this time,



TRAP SHOWING LOCATION OF AUTOMATIC AIR VALVE

will run back nearly horizontal, instead of dropping down nearly to the pressure of the atmosphere as the card from the crank end does.

This high-pressure steam valve seems to be leaking badly, and if it developed suddenly, I should look for a twisted valve stem. Wilmer R. Hersey.

AUTOMATIC AIR VALVE ON STEAM TRAPS

IN the best known tilting steam traps the disadvantage of becoming air bound has not altogether been eliminated. As the trap becomes nearly filled with water, not being properly vented to the atmosphere, air forms a back pressure on the inlet pipe and the trap will not fill, thus decreasing its efficiency. A tilting trap consists of a tilting body balanced by a counterweight, when filled to sufficient height, so that the weight of condensation overcomes the counter-weight, the trap tilts downwards, allowing to water to flow out through a discharge pipe directly into the receiving tank or hot well.

To prevent air binding in the trap, an automatic air valve should be located on the top of the trap to let off any accumulation of air which may be confined there under pressure. Lewis A. Danner.

STEAM LINE JOG

AFTER studying diagrams taken from C. W. Bennett's engine that has been in service for 25 yr., I have come to the conclusion that the jog in the steam line is due to lengthening exhaust valve rod effecting a slight leak by valve overtraveling its original seat.

I would suggest that he set the valve back to its original position as when No. 1 card was taken which is free from any irregularities. If the jog is then shown as in 2, 3 and 4, I would suggest trying another indicator as it is possible that the fault lies in the instrument. If the 2 indicators take the same kind of a diagram, I would think as I did at first that the maximum pressure is not attained until the piston is well started in its stroke and I would think there was a slight leak by the piston in that part of the cylinder.

J. W. Dickson.

STUFFING BOX AS GUIDE FOR WATER LEVEL

WHILE Mr. Gee was shredding fodder a friend of mine having a few leisure hours made him a call and being an engineer naturally took a seat on the tool box of his traction engine. Glancing over the engine for something to talk about he observed that the gage glass was broken. My friend asked Mr. Gee how he liked to run his boiler by the test gages.

The reply he got was that he "never fooled with them tricks" and explained that when the water was high enough it would squirt out at the stuffing box around the piston rod and when the water was getting low steam would come out instead of water. He had been running 3 days by this method.

Strangely enough my friend concluded his weight was no longer needed to keep the tool box lid down.

Albert Wright.

A PUMP EXPERIENCE

IN one of the plants where I was formerly employed as assistant engineer we had a peculiar accident happen to one of our air-pumps, a Conover. We had a severe pound in the water-end connecting-rod, every way possible was tried to stop it, the only thing that helped it was keying up on the bottom boxes on the connecting-rod, this would stop it for a short time only and then it would begin again as bad as ever. In the Conover type of condenser the water-end consists of a plunger of trunk type, the trunk was so deep that it was impossible to reach the lower connections on the rod, the only way we could do was wait until the pump was stopped and then reach down in the trunk and feel the rod, with hard straining we generally reached about 6 in. above the boxes but we never felt any unusual heating there, so we had to let it go at that.

The plant was in a badly run down condition at that time so we were kept pretty busy going over other troubles that seemed more important and we had to let it wait its turn. The chief was new at the plant and so were both the assistants.

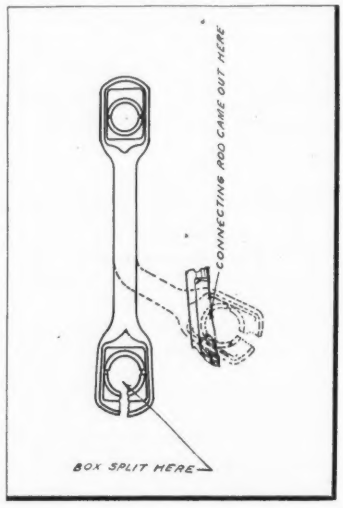
One Saturday morning about 7:30 o'clock I was on my rounds of the bearings and had just left the low-pressure main bearing and was walking towards the air-pump when it gave a crash that could be heard out in the yard. I closed the throttle and looked down at the pump when I noticed that the connecting-rod was out of place, instead of being in the bottom of the trunk on the pin it was pushed through the side of the trunk and operated the bucket for a stroke from here, when it came in contact with the discharge valve deck it slipped out and the bucket dropped down and the rod was free, then the pump stopped.

This type of air-pump is fitted with a large flywheel the momentum keeping the pump moving a short time after the steam is shut off. If no one had been near the pump at the time of the accident no doubt we would have had a new flywheel to install for the water-end was now entirely disconnected from the steam end and there was no safety device on it. When we had a chance to look for the cause of the trouble we found the reason for the pound. The lower half of the brass boxes was split in two and evidently had been for some time, the results were that every time we keyed up on the lower boxes we only pushed the pin down between the broken parts of the boxes and spread them apart, and of course spread the strap that went around them until it gave away and left the rod free from the pin and it came up and out through the side of the trunk. The jar was so great that of the 4 bolts holding the flywheel hub 3 were sheared off, the fourth remaining in position and seemed all right. The lower part of the rod was bent to an angle of 40 or 45 deg.

In the accompanying sketch is shown as nearly as possible the damage done. We ran for about a month on high pressure waiting for a new bucket and trunk coming from the makers.

When we started the pump again there was a continual pound in it that seemed to come from no place in particular for it shook the whole pump and condenser on every revolution, it was running at 40 r.p.m. The pump was stopped and everything gone over again to see if we had left any connections loose, but none could be found. When we started the pump we started the pound, we ran this way for 3 days when the pump stopped on the center one noon. The flywheel had holes all around for inserting a bar to pry over the center. When I tried to bar it over I noticed the wheel fall back about 2 in. with the weight of the bar and the shaft never moved. On investigating we found the key-way in the wheel and shaft spread about ¼ in.

On the following Sunday we put in a new key ¼ in. larger than the old one, then heated the bolts to a dull red, placed them in position and drew up on them, then allowed them to cool off. This ended our troubles with the pump. This happened about 3 yr.



BROKEN BRASS AND RESULT

ago and the pump has never given any trouble since. The pump was used in connection with a 2500 hp. cross compound Corliss engine.

On another pump of the same type used with an 1800 hp. Corliss, the vacuum was always about 22 or 23 in. on investigating we found a number of small holes in the bottom or channel-way. Building a trough around the outside and keeping it filled with water from the discharge pipe by inserting a ¾-in. valve in the bottom of the discharge and letting enough water run out to keep the trough filled brought the vacuum up to 26 in.

A. A. L.

PAINTING A CONCRETE FLOOR

I HAVE visited engine rooms that were in a very untidy condition in regard to the appearance of the cement floor around the engines, it being covered with grease and oil spots.

In a plant where I worked 5 years there were 3 automatic high-speed and 2 Corliss engines. The floor around each engine for a space of 2 ft. was given a coat of good lead paint mixed with varnish, every two months.

It was the work of the night oilers to wipe this painted floor every morning, about the last work before going off watch. The old oily waste which was used gave the floor a bright, clean appearance which lasted for the greatest part of the day watch.

Fred L. Wagner.

STATIC

ROSCOE was the chief's dog, and if a dog ever possessed any real sense, Roscoe did. He would come down to the plant every morning at work time and stay until evening, and was as steady as any man in the plant. His official position was the day oiler's 6th assistant, which job he held with intelligence to be admired. He would walk around the machinery, hunt for hot boxes and make himself generally useful.

But not-with-standing the fact that Roscoe's ability as an experienced and able engineer could not be doubted, he was not very well versed in static electricity, and his desire to learn, together with his natural dog curiosity, brought on quite a catastrophe one day as he was giving the second engineer a lecture over by the big belt. Now this belt was heavily charged with static and as you all know, static likes to jump at points; consequently, when Roscoe, trying to convince the second that the oiler was hiding over behind No. 3 Turbine smoking a cigarette, accidentally got his tail a little too close to the belt, the sparks began jumping for his tail.

His canine Majesty first suspected flees, but after looking all over himself and not finding any, decided to investigate the belt. He approached cautiously, but remembering that belts are dangerous, paused, then turned his head to one side and looked wise. But his curiosity was aroused and he lost all of his caution and ventured to take a smell. When his nose came within about an inch of the belt the sparks began jumping again, this time to the end of his nose. This was too much for Roscoe, and with an angry snarl he fastened his teeth in the belt. Then there was a howl and we heard a lot of cuss-words in dog language, for Roscoe had stuck to the belt and was thrown with the force of a cyclone against the engine bed. He came out of it whole, save a bunch of hair and some sore ribs, and he was, ever after, a much wiser dog.

H. R. Siders.

A PECULIAR BOILER

TO show the ignorance of things mechanical of the average newspaper reporter I enclose a clipping which apparently is a Press Association dispatch and deals with a type of boiler construction which may be unfamiliar to some of the readers:

"Conn., Feb. 18.—Charles Culver, a section hand on the 'Storm King' will probably loose his leg and is suffering from severe burns as the result of being practically locked in the huge boiler of the boat. His home is in Jersey City, but he is at the Mercy hospital and will be there for some time.

"There had been trouble with the boiler all the way up from New York and Culver was sent from the deck to see if he could make the necessary repairs. His arrival in the boiler room was unnoticed and he crawled into the boiler and was at work there when the strong wind blew the heavy door shut and it was locked so that it was impossible to open it from the inside.

"Not knowing that Cluver was inside the boiler, Elisha Alling turned on steam and though Culver shouted the sizzling of the steam drowned his cries. He rushed toward the door but the steam was so thick that he could not find it and was badly burned; he pounded on it burning himself more severely and finally attracting the attention of Alling who opened the door and Culver fell out unconscious."

The question arises in the mind of an engineer what kind of a boiler had a door which would blow shut with snap catch and how there would be room inside for Culver to rush around trying to find the door?

C. Dickerson.

UNEQUAL CUTOFF CAUSED BY ANGULARITY

MOST instructions tell us, in setting the 4-valve engines, to block up the governor and set the valves accordingly; but if we make no difference in the blocking up, there will be a difference in the cutoff as shown by indicator cards, the crank end being the short cutoff.

Suppose the engine is turned over slowly and the governor blocked up to cutoff at ⅛ revolution, as at A on the outward stroke and B on the return stroke; it is evident, with no correction of the governor, that when

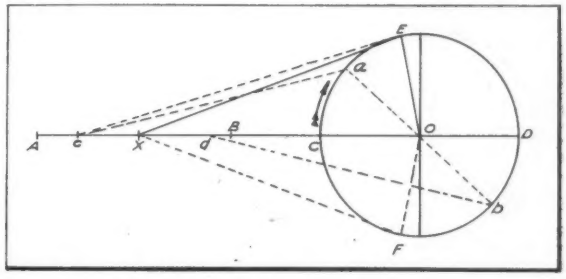


DIAGRAM SHOWING EFFECTS OF ANGULARITY

cutoff takes place the piston will travel the distance Ac on the outward stroke, and the distance dB on the return stroke. Therefore, it is plain that the point of cutoff in the crank end is much shorter than in the head end, as will be seen by comparing the distance dB with Ac.

I have talked with old engineers who have told me that this is impossible, and that cutoff is the same at both ends, if the valves are set the same at each end; but a close study of this diagram will convince anyone that such is not the case. By putting an extra piece of blocking under the governor when adjusting the knockoff cam rod, indicator cards would look different.

J. G. Brown.

REVERSING THE ICE PLANT

WHILE we had some very cold weather in this section of the country we had no such experience as chronicled in the article under the head of "Not a North Pole Expedition" in the February 15th issue of Practical Engineer. We did have it cold, and cold at that. We fellows in the power house had to hustle all the time to keep things from freezing up—and we didn't do it. One day when we had got pretty well tired out (every man was working over time) and it was colder than ever and getting colder, one of the wipers had a brilliant idea. He thought that if that blamed old ice machine will make cold going forward, it ought to make heat going backward. So he reversed the machine and started her up. I am glad to say that we are all enjoying ourselves at the present writing and everything is running smoothly—and forward. Up to the present none of the language used has thawed out.

C. A. Scott.

Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

Connecting 2 and 3-wire Systems

IN the February 1 issue a correspondent asked if it was possible to feed his 2-wire system from the 3-wire generator, but does not state whether the voltage is the same or not. My impression from past experience is that it is a 3-wire lighting circuit and a 2-wire motor

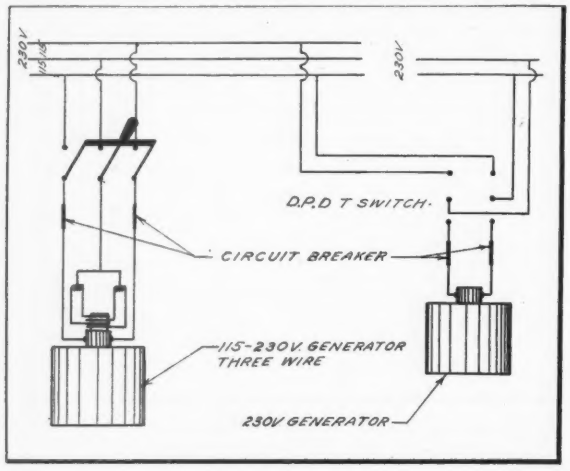


FIG. 1. METHOD OF CONNECTING A 2-WIRE AND A 3-WIRE SYSTEM

circuit and the probable voltages are 115-230 on the 3-wire and 230 on the 2-wire system, as this is common practice, and a separate machine is used for each system.

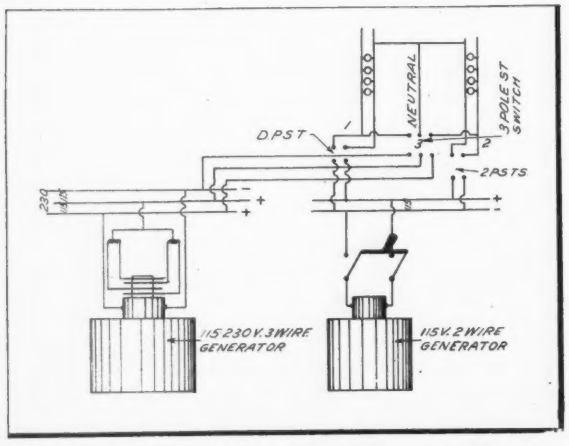


FIG. 3. THIRD METHOD OF CONNECTING A 2-WIRE AND 3-WIRE SYSTEM

In this case it is only necessary to connect the 2-wire circuit to the outside wires of the 3-wire circuit through a switch, neglecting the neutral circuit entirely, as the load will be on the two outside wires. This is shown in Fig. 1. I would suggest a double throw switch, as shown, to prevent tying the two machines together.

Answer in the February 1 issue assumes the voltage on the 2-wire circuit to be the same as one side of the 3-wire circuit, which is usually 115. If this is the case, he can connect to one side of the line as the

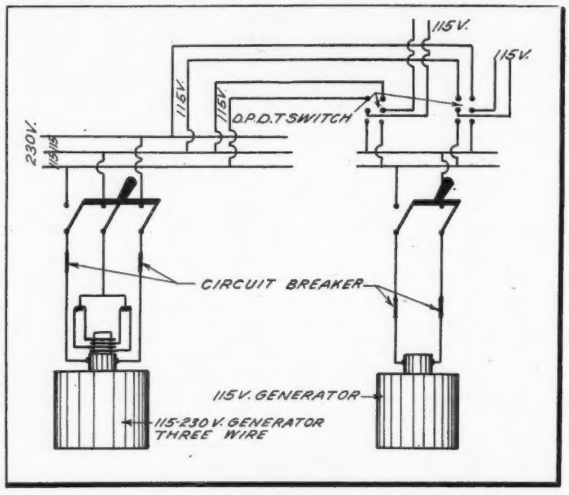


FIG. 2. DIVIDED 2-WIRE CIRCIUT IN CONNECTION WITH A 3-WIRE SYSTEM

answer states, but I would suggest that a better way would be to divide the 2-wire circuit in such a manner that he can put about one-half of it on each side of the 3-wire system, as shown in Fig. 2, thereby giving

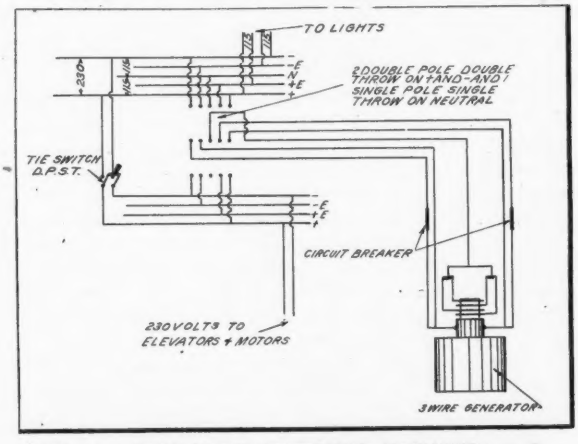

TO LIGHTS
230
2 DOUBLE POLE, DOUBLE THROW ON 1 AND 2 AND 1 SINGLE POLE, SINGLE THROW ON NEUTRAL
TIE SWITCH D.P.S.T.
CIRCUIT BREAKER
230 VOLTS TO ELEVATORS & MOTORS
3 WIRE GENERATOR

FIG. 4. THREE-WIRE GENERATOR OPERATING A 3-WIRE AND A 2-WIRE SYSTEM

better balance and throwing less load on the balancing set.

There is another method which may be used with the 2-wire circuit voltage the same as one side of the 3-wire system; that is to run a third wire for the neu-

tral and tap the circuit one to each of the outside wires, as shown in Fig. 3.

At the present time I am operating 4 3-wire machines that may be used for either 2 or 3 wire circuits as desired. The lighting circuit is 3-wire 115-230 v. and the motor load 230 v. We have 2 sets of busbars, as shown in Fig. 4. When the switches are thrown up the machine is on the 3-wire circuit, and when thrown down on the 2-wire circuit. The 2 sets of busbars are also tied together so that one machine can feed the whole system or a separate machine can be used on each, as desired. The reason for this is that the lamps are all high efficiency Mazda type and the motor load is largely elevators. The ammeter on the elevator circuit often fluctuates 150 to 200 amperes, which with a good load on the generators will cause the lights to wink. At the present time the whole load is carried on one machine, as it is not large enough to rquire 2, except on dark days, at which time the load is divided with one machine running the 2-wire circuit and the other the 3-wire circuit. Fig. 4 is submitted in the hope that it may offer some suggestions to the correspondent. J. C. Hawkins.

Compound Engine Troubles

COULD you kindly answer the following questions?

1. How will excessive clearance on head end effect indicator diagram?

2. If running compound engine with dependent condenser and connection from condenser to engine broke off what would you do? No atmospheric relief valve is fitted to condenser. A jet condenser is used.

3. How can you tell without disconnecting anything whether or not the crank shaft is at right angles to the center line of the cylinder?

4. How would you set the valves on tandem compound engine having one eccentric? F. M. P.

A. If the clearance on the head end of a steam cylinder is excessive (assuming that valves are correctly adjusted), the compression line will not run up so high as if the clearance were less and there would also be a general tendency of the admission to show up late.

2. If the driving connection between a compound engine and its dependant condenser broke, and the break was of such a nature as not to interfere with the operation of the engine as a whole, that is, not cause a wreck from the broken driving rig interfering with the moving parts, the first move would be to shut off the condensing water at once, if received under pressure. Where no relief valve is provided, and a jet condenser is used, the back pressure on the low pressure cylinder, owing to restricted exhaust outlet, would preclude the possibility of water entering the cylinder and damaging it.

This back pressure would force its way through the suction and discharge valves of the condenser and out through the tail pipe and possibly the suction pipe if no valves prevented. The excessive back pressure would cause the engine to slow down rapidly, when the throttle should be closed gradually and the engine stopped.

Practically all condensing engines are provided (or should be) with an easily opened quick-acting valve placed as near to the exhaust flange as possible, on the final cylinder, whether the engine is simple, compound, or multiple expansion, and this should be opened at once upon the occurrence of a break as described in the question.

3. If the crosshead end of the connecting rod hugs the side of the crosshead next to the wheel (provided that the engine was designed and constructed so that the rod end should travel central on the crosshead pin), the center lines of engine and shaft will form an obtuse angle. If the end of the rod hugs the opposite side, the center lines will form an acute angle.

To check up, place a straight edge across the back end of back cylinder head (they are almost universally machined) so that it extends in the same plane and approximately parallel to the shaft. Then with a steel tape or other accurate device measure from the straight edge to the shaft up close to the main bearing, and again as close to the outboard bearing end as possible, making necessary calculations for any difference in diamter of the shaft.

Another way is to note whether the crank disk has an open space between it and the side of the jaws of the frame, on one side of the shaft, and none on the other; and if the collar on the shaft on the wheel side of the bearing shows clearance, or none, opposite to what it does on the crank disk, then it is safe to say that the engine is "out of square." Use a thickness gage or thin strips of metal or even stiff paper to determine the amount of clearance.

4. On a tandem compound engine, the valves are set so that the various corresponding events in each cylinder will take place simultaneously. Local conditions, however, must govern the closure of the exhaust port, in each cylinder, as compression is governed somewhat by the receiver pressure, and vacuum maintained. G. H. W.

Erecting a Traction Engine

WHAT is the best way to assemble the working parts of a traction engine?

2. How do you determine the proper length of a reach rod, eccentric rod, and valve rod on a reversible steam engine?

T. F. M.

Ans. 1. In replying to your first question, we presume from the tone of the preceding remark, that you refer to the assembling of the working parts on a traction engine. First see that all the various parts are cleaned thoroughly and that all the bolts, nuts, setscrews, etc., are in good working condition. Place the main shaft in the bearings and see that the boxes are in serviceable condition. Put on the bearing caps, using shims of tin, sheet iron, or strong paper of the desired thickness so that when the caps are pulled down tight, the shaft will be a good fit in the bearings and still run quite free.

Eccentrics having been put on the shaft when it was put in, put the straps on the eccentrics, using shims and bolting the 2 halves of each together so that the straps will revolve freely around the eccentric. Assemble the link and slide block, using the same care to see that the various parts are a snug fit and at the same time allow a free movement of the slide block in the link.

If the engine has a carrier arm to support the end of the valve stem and the slide block, next place this in position and attach the link and slide block to it. Put the eccentric rods on the eccentrics and secure the other end of the link, shifting the eccentric sideways slightly as required to bring the end of the rod in line with the link and measure the distance from the eccentric to some stationary object, such as the end of the bearing, for reference, and for the present, let the eccentrics hang free on the shaft.

Put the valve in the steam chest and pass the valve stem through the gland and through whatever devices that are provided to receive it on the back of the valve, and fasten the other end to the carrier arm in the place

provided for it. Attach the reverse lever to the link with the various rods and bell cranks that are usually supplied. All of the valve gear is now in place.

Place the crosshead in the slide and adjust the shoes to a snug fit. Put on the connecting rod, using the same care to secure a good fit at the pins. Put the piston rod in the cylinder and note that the gland of the stuffing box is in place and that the jamb nut is on the rod before it is screwed in to the crosshead, as failure to observe the 2 latter precautions may make additional work.

Adjust the piston so that it will have equal clearance and put on the cylinder head. Now place the engine on the center, say, the back one. Adjust the valve stem so that when the "go ahead" eccentric is revolved around the shaft that the valve will travel equally on either side of the steam ports, and when equal, mark the extreme of travel on the face of the valve with a lead pencil, and do the same with the other eccentric, adjusting its eccentric rod so that when the reverse lever is in the "back up" position that the valve will travel to the pencil marks.

With the reverse lever in the forward position, roll the "go ahead" eccentric around the shaft in the direction in which the engine is to run until the desired amount of lead is secured. Throw the reverse lever shaft in the direction opposite to the other eccentric and when the same lead has been secured as in the first instance, place the engine on the other center and if, on throwing the reverse lever in the forward and backward positions, the lead is found to be the same as on the other end in both positions, the work has been correctly done. Put on the chest cover and move the engine off the center.

2. The link of a reversing engine should be located in such a position that the radii will coincide in the center of the shaft. From this proper calculations can be made for the connections at the 2 ends as required. From this position also, the valve rod should be the distance from the center of the slide block to the center of the exhaust port, making such additions or subtractions as the design of the engine requires.

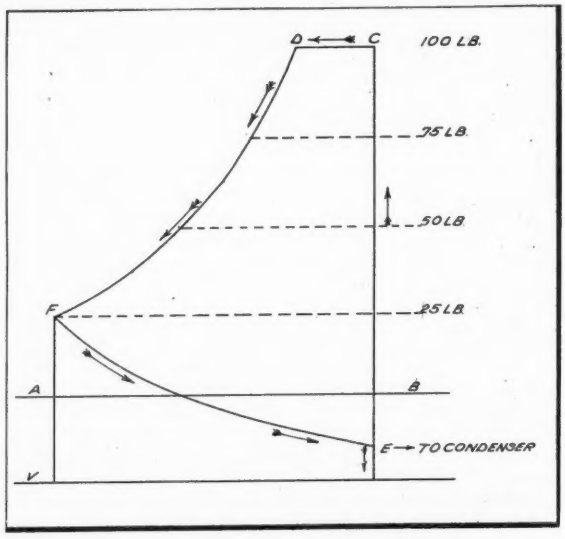
The reach rod should be of such a length that when the reverse lever is in the 2 extreme positions, that the link will also be in the extreme positions.

Woolf Engine Valve Gear

SHOULD like some information concerning the setting of the Woolf valve gear with the eccentric set 180 degrees from the crank. I have experienced considerable trouble in setting the stand on this valve gear. A. H. M.

A. Woolf reevrsing valve gear which is used to a large extent on traction engines, employs but a single eccentric, set at an angle of 180 deg. with the crank. An arm is cast to the eccentric strap having a wood block pivoted at its end. This block slides in a pivoted guide, the angle of which is controlled by the reverse lever. By changing the angle of this guide, the cut off can be varied as desired, or the motion of the engine may be easily reversed. To the eccentric arm is attached the eccentric rod which transmits a horizontal motion to the valve rod by means of a rocker arm on simple engines, or through the medium of a slide if the engine is a tandem compound. The valve, being a simple slide valve, its adjustment is merely a question of, first, placing the eccentric at exactly 180 ahead of the crank, and firmly securing it there; second, equalize the lead, which should be between 1/16 and 1/32 inch. Owing to the fact that some of the wearing surfaces are of wood, it is probable that there will be more or less lost motion in a valve gear after it has been operated awhile, and this no doubt is the cause of the trouble our correspondent is having with his engine.

In the Woolf two cylinder compound engine the steam having done work in the h. p. cylinder is exhausted direct into the l. p. cylinder, and thereby avoids the cooling effect of a receiver. But it is evident that in order to obtain the ideal performance of work by the steam in this type of engine, the valve action must be practically perfect. The high pressure steam valve should be adjusted to admit steam at the beginning of the stroke, and cut off should occur at about one third of the stroke in the h. p. cylinder. Immediately upon completion of the stroke of the h. p. piston the intermediate valve should open wide, and admit the steam (now expanded to three times its original volume) into the l. p. cylinder where it can act against a piston having an area of 3.5 to 4 times the area of piston number one. It is also essential that the intermediate valve remain open during the whole



IDEAL DIAGRAM OF A WOLF ENGINE

of the stroke of the low pressure piston, in other words "cut off" in the l. p. cylinder does not occur until at least seven eights of the stroke has been completed.

This adjustment of the valves will leave the final pressure and the volume of the steam in the l. p. cylinder practically the same as if the initial steam had been admitted directly into the larger cylinder, and expanded to the end of the stroke, as with a single cylinder engine. The net work done by the steam would be the same in both methods of distribution but the unequal strains upon the single cylinder would be much greater—prohibitive in fact. The figure shows an ideal diagram of the action of the steam in the two cylinders of a Woolf compound engine, as it would be described by the indicator, provided the valve adjustment is correct. In the figure A is the line of atmospheric pressure, and V is the line of perfect vacuum.

From B to C is the line of admission, and C to D is the steam line, the arrows showing the course of the steam. At D cut off occurs, and from D to F is the expansion curve in the h. p. cylinder. At F the

intermediate valve opens, admitting the steam at once from the h. p. to the l. p. cylinder, and the curve F E represents the consecutive expansion line of back pressure for the return stroke of the h. p. piston, and of positive pressure for the steam stroke of the l. p. piston. At point E, which is the end of the stroke of the l. p. piston, the steam is exhausted into the condenser, and the pressure drops to the line of perfect vacuum.

It will be noted that the diagram of the l. p. cylinder, shows no specific period of admission, such as is represented at C D in the h. p. diagram. On the contrary the whole of the l.p. steam line, F. E. is expansional, being in fact a continuation of the expansion of the initial body of the steam contained in the h. p. cylinder. If we assume cut off to have taken place at one third of the stroke, the total number of expansions will be between 7 and 9, depending upon the ratio of the cylinder areas.

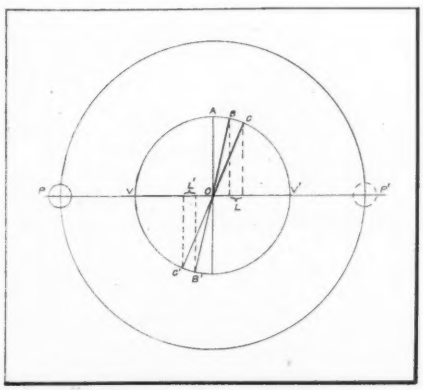
Moving Eccentric

WE have a J. I. Case single cylinder traction engine. If we loosen the eccentric and move it half way around the shaft, what would the result be? Would the valve be properly set or not, no other changes being made?

H. H.

A. The engine could not run if the eccentric was moved through 180 deg. This is shown as follows:

In the diagram, the large circle represents the path of the crankpin and PP′ the piston travel. The piston is represented as being on head end dead center. The small circle represents the eccentric circle, and VV′ the throw or travel.



ECCENTRIC DIAGRAM

In ordinary D valves, the eccentric leads the piston, or, we may say, the crankpin, by 90 deg. plus the lap, plus the lead. The eccentric then is ahead of the crankpin by the angle VOC, and the valve is open on head end by an amount represented by L, the angle BOC representing the lead. With valve set in this manner the engine is running over.

Now, leaving crankpin on head end dead center, throw ccentric half way around; it is now behind the crankpin or piston by the angle VOC, or, more plainly, the steam port is open on the crank end by an amount equal to the lead, or L′. Therefore, with the piston on head and dead center, steam is admitted at full boiler pressure from the crank end port, which will hold the piston firmly in its position.

Governor and Valve Adjustment

ON any make of steam engine, with valves properly adjusted, if the clearance is excessive on the head end, how would this affect the indicator diagram?

2. Can you use a loose eccentric shaft governor on a single-valve engine?

3. Where would you place the rider eccentric to cut off at quarter stroke on a riding cutoff engine?

4. On a riding cutoff engine with indirect rocker arm on rider shutting off at half stroke, how would you reverse the engine?

5. Please send me the best way of setting the valve on a double eccentric engine and at what angle to set the eccentric with the crank.

H. J. A.

Ans. If the clearance on an engine is greater at the head end with the valves properly adjusted, the compression line will not run up as far as it would if the clearance was equal and under certain conditions would cause the admission line to appear late. On the crank end, the reverse would be the case as the small amount of clearance would cause the compression line to run up nearer the top of the diagram; possibly it might run up above the steam line.

2. Practically all makes of single valve automatic engines use some form of a shaft governor which shifts the eccentric to meet the various changes of load and steam pressure to maintain a constant speed.

3. This depends on the design and size of the engine. We assume from the question that the eccentric operating the riding cutoff is not of the automatic type operated by a shaft governor, but is fixed on the shaft when once adjusted. Set the main valve first without regard to the riding cutoff. Then adjust the riding cutoff for travel, and having rotated the engine in the direction it is to run until the piston has traveled one quarter of the stroke rotate the eccentric of the riding cutoff in the same direction until the rider cuts off and then fix it on the shaft. Check up on the opposite end of the stroke and, if the valves function the same at both ends of the stroke, the valve is properly set.

4. Assuming that the eccentrics of the engine are fixed on the shaft and that the valves are properly adjusted, place the engine on the center; tram from some convenient fixed point on the stuffing box to the valve stem of the main valves and make a mark with a light prick punch. Rotate the eccentric in the direction in which the engine is to run until the tram coincides with the two marks again and fix the eccentric on the shaft. Proceed in the same manner with riding cutoff, and if the work is carefully done the engine will rotate in the opposite direction.

5. In setting the valves on a double eccentric engine, ignore each eccentric and its valve gear entirely while adjusting the other one. Assuming from your question that you mean a double eccentric Corliss engine, see p. 25 of Jan. 1, 1912, issue.

The angle of the eccentric with the crankpin is immaterial as this differs with the various types of engines, within certain limits.

G. H. W.

THE PEOPLES GAS LIGHT & COKE CO., Chicago, have just placed the order with The Terry Steam Turbine Company for 5 extra heavy turbine driven gas blower sets, each with an actual capacity of 16,000 cu. ft. per min. The blowers are of the high-pressure type and are direct connected to noncondensing Terry steam turbines. This order is the 19th received by The Terry Steam Turbine Co. from Chicago companies.

HEATING AS A PLANT BYPRODUCT

(Continued from page 289.)

FOR preventing radiation of heat from the line a wood casing, Fig. 12, is made of carefully selected live white pine timber thoroughly air and kiln dried, which is then cut into radial staves, each stave having a tongue and groove running its full length. The staves are firmly bound together with 3/16-in. galvanized steel wire wound spirally under heavy tension and pressed by means of a steel roll so that it is embedded in the wood, flush with the surface, leaving the outer surface practically smooth. This casing is then coated with a quarter in. of asphaltum pitch and afterward rolled in sawdust so that it will handle without being sticky.

Inside, the tube is lined with special 4A charcoal tin plate and the ends of this lining are brought up over the ends of the wood so as to give a tight joint. An air space of 2 to 3 in. is left between the iron pipe and the tin casing and about ¼ in. between the tin casing and the wood, and it is found that this tin casing and ¼ in. air space make a difference of some 7 per cent in the condensation in the pipe. The ends of the sections of casings are joined by round mortise and tenon, the mortise being 4 in. long and the tenon 4½ in. deep and the space being filled with creosoted oil and asphaltum to protect from moisture. This casing, as will be recognized, furnishes protection against electrolysis from current and also to give efficient protection against the loss of heat.

Tests made at the university of North Dakota on the condensation in pipe lines showed that with a pressure of from 16½ to 18½ lb., with condensation in bare pipe taken as 100 per cent, in a pipe covered with air cell asbestos, was 28.2 per cent; covered with hair felt 27.7 per cent; covered with asbestos magnesia 22.1 per cent; and covered with a wood log casing 15.3 per cent. The factor of transmission condensation in a pipe line covered with this casing has been found to be from ½ of 1 per cent upward, depending upon the flow of steam in the pipe. It is found that when properly installed so that it is kept dry and free from water this casing has a durability of years under ground. The important point in constructing an underground system is to prevent any water coming in contact with the pipe. This problem is solved by giving thorough under drainage by means of rough drain tile, broken stone in the trench under the pipe and a protection of heavy tarred paper above the pipe.

Metering Heat Supply

FOR the buildings which have been in use for some time, the ordinary pressure system of exhaust heating is used a pressure of 3 to 5 lb. being carried on the radiators and heating coils. In such a system, however, where central station heating is used and, if the water is not returned to the station, the building is provided with an economy coil in the basement which has indirect radiation to take heat out of the water, so that the water is discharged barely warm. It then passes from the economy coil through a meter to the sewer and the customer in central station heating is charged according to the amount of condensation thus passed, as that is an indication of the amount of heat supplied.

In order to do this it is necessary to have a satisfactory form of condensation meter and the Simplex Meter has been developed for this purpose. As shown in the sectional view, Fig. 13, the measuring device is a bucket or a receptacle divided into 2 equal compartments and mounted on a bearing so that a tilting movement is caused by alternately filling and emptying the 2 compartments. The weight of water required to cause the bucket to tip is determined beforehand and it determines the capacity of the meter. This movement of the bucket back and forth is re-

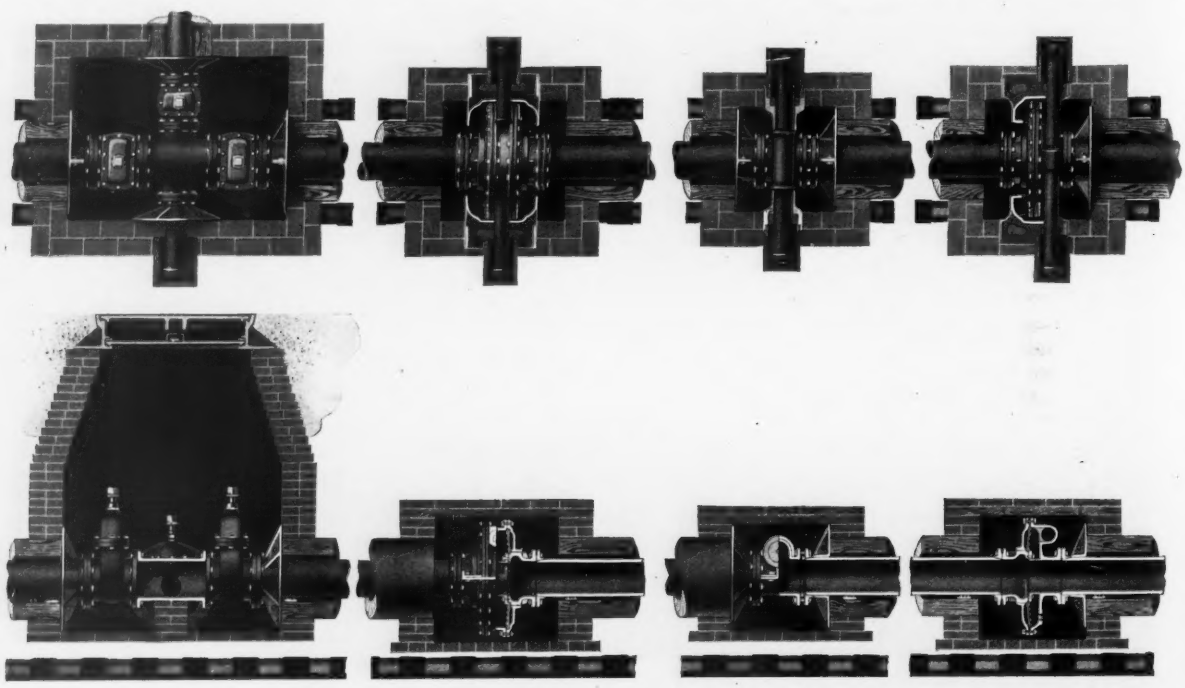


FIG. 11. PLAN AND SECTIONAL ELEVATION OF UNDERGROUND CONSTRUCTION WITH "VARIATORS"

corded by the registering device and each movement means a certain amount of water delivered to the bucket and dumped, Fig. 14. Thus an accurate record is obtained of the weight of condensation passing through the meter and as a usual thing 1000 lbs. of condensation is taken as a basis in computing charges and in determining cost and selling price of steam.

This system of metering the condensation is employed in the plant of the American District Steam

FIG. 12. WOOD CASING USED ON UNDERGROUND LINES

Co., to determine the amount of steam used in each department, and each department is charged with this heating the same as a customer would be by a central station.

Shop Heating by the Atmospheric System

IN the machine shop the atmospheric system is used and it is found capable of handling even so difficult a problem as this with the greatest of ease. The shop as seen in Fig. 2 has 2 floors and is of steel frame construction with brick curtain walls and reinforced concrete floors and roof. On the first floor are located the machine shop, the tool room, brass shop, meter shop, assembling floor and carpenter shop, and on the second floor are the testing and packing rooms, the copper shop where the meters are built, general offices, drafting room and stores.

Arrangement of an atmospheric system is as indicated in Fig. 15. A reducing valve cuts the pressure from 3 lb. down to 8 ounces and steam is then car-

FIG. 14. METER TESTING DEPARTMENT

ried into the supply mains, which should be installed as a complete loop in order to insure uniform supply pressure to the radiator. The steam is then led to the top of each radiator, the supply pipe being reduced to ¾ in. at a point not more than 4 ft. from the entrance to the radiator.

Radiation should be of the same type as is used for hot water, that is, with connection on both sides of the coils through from top to bottom, so that the steam may flow uniformly downward throughout the radiator.

The graduated supply valve is arranged so as to use part or all of the radiating surface as may be desired. It is marked for ¼, ½, ¾ and full on, but any graduation between these may be used. Steam is supplied through a narrow slot, which, as the valve is raised, is opened sufficient to supply just what steam can be condensed by ¼, ½, ¾ or all of the radiating surface. It will be noted that in the Fig. 15, the lower part of the radiator is shown in white, as not being filled with steam even when the supply valve is full on. This part of the radiator is filled with hot water and acts as hot water radiating surface, thus taking out all the heat from the water as well as from condensation of steam. For this reason it is necessary to use a radiating surface 20 per cent larger than would be used for ordinary pressure or vacuum steam heating, this radiating surface serving as hot water radiation and contributing to the economy of the system.

Return is taken from the bottom of the radiator to a return main, and it should be noted that the supply to each radiator is taken on an independent riser as the

FIG. 17. TEST OF RADIATORS FOR EFFICIENCY OF SURFACE

steam pressure is so small that a draft of steam flowing by one radiator connection might interfere with the supply of steam to that radiator. Condensation is taken through the main return pipe to a receiver, this receiver having an air vent into the chimney to put a slight draft or pull on the return system. The condensation flows through the water seal from the receiver to the meter and is discharged to the sewer.

Although conditions vary widely in different buildings, the sizes of pipe needed to supply various amounts of radiation may fairly be taken for common practice as given in Table 1.

The reason for the use of the atmospheric system in place of the pressure system of exhaust heating is a saving in the amount of steam used. This comes partly from the use of a graduated valve, so that just as much steam as is needed may be used at all times, partly from the fact that all heat is taken out of the steam before it is allowed to leave the radiator. The saving has been found by repeated tests to be from 20 to 30 per cent of the steam consumption when using pressure systems.

In passing through the meter testing department, some interesting tests of radiators were noticed to determine the effectiveness of different methods in finishing. Mr. Hall, the treasurer of the company, becoming interested in some statements recently made that the use of aluminum and bronze paint for radiator finish is not efficient, undertook these tests, with the result that taking the bare iron radiator shown at the farther end, as 100, the condensation from a radiator covered with aluminum or bronze paint was found

TABLE I. SIZES OF SUPPLY PIPE FOR RADIATION

Square Feet of Radiation	Main Steam Pipe	Return Pipe	Length of Pipe of Given Sizes—(see note)
50 feet	¾ inches	½ inches	30 feet
75 "	1 "	¾ "	60 "
125 "	1¼ "	1 "	70 "
200 "	1½ "	1 "	70 "
300 "	2 "	1¼ "	140 "
600 "	2½ "	1¼ "	200 "
900 "	3 "	1½ "	250 "
2200 "	4 "	2 "	300 "
3600 "	5 "	2 "	350 "
6000 "	6 "	2½ "	650 "

NOTE: If greater length of pipe is required than is given in the table, use next larger size.

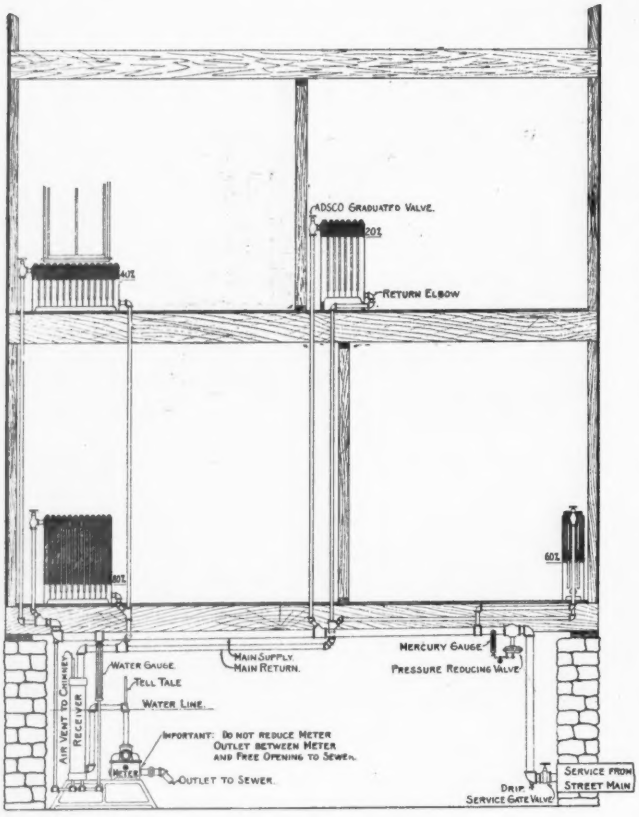


FIG. 15. ARRANGEMENT OF ATMOSPHERIC HEATING SYSTEM FROM CENTRAL PLANT

to be 80. The nearest radiator at the time of taking the picture was covered with white enamel paint and showed a condensation of 101, and other paint finishes of a light color have shown like results. It would seem therefore that it is highly desirable to finish all radiators in a paint or enamel to match the decorations of the room in which the radiators are placed.

Mr. Hall is also securing by observation a good deal of data in regard to the amount of heat necessary in reinforced concrete buildings. By observation in the new shop he has found that the radiation through reinforced concrete is much more rapid than through a corresponding thickness of brick wall, this being particularly the case where there is a reinforced concrete roof without a ceiling below the rafters. He will have after a time some interesting data to present on this subject.

In the entire visit through the plant one is impressed with the high grade of all equipment used.

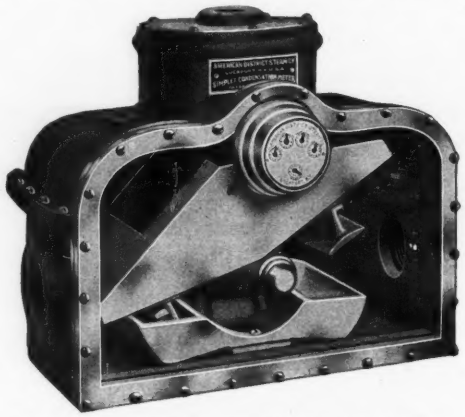


FIG. 13. SIMPLEX CONDENSATION METER

Provision is made for the most convenient handling of work for good light, good air, good ventilation, convenient and sanitary toilet facilities, and to crown all and be entirely up-to-date, a restaurant is provided where luncheon is served to the heads of departments, the officers of the company and the office force; and this is prepared in an electric kitchen having all devices

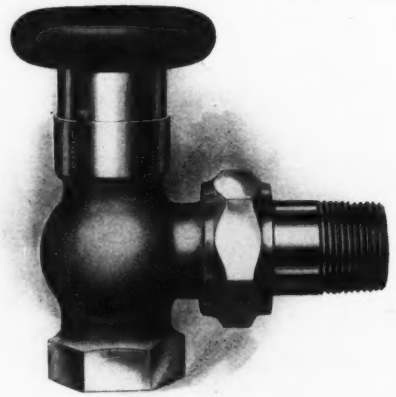


FIG. 16. GRADUATING VALVE FOR CONTROL OF STEAM SUPPLIED TO RADIATOR

for cooking electrically heated. This is as it should be to correspond with the up-to-date heating methods and latest advances in heating which are advocated by the company.

CORRECTION

I WOULD call your attention to a slight mistake in Mr. Howarth's article in Feb. 15 issue, page 178, under the heading, "The Slide Rule Saving" in next to the last paragraph, where he divides by 115 and multiplies by 11 he says, "and over 1 on B find 297 on A."

He should say over 11 on B find 297 on A.

W. R. Hersey.

IT IS MORE dangerous and wearing upon a plant to overload than to underload it though the efficiency may be increased by overloading.

Problems for Discussion

What Would You Do Under These Conditions?

Unusual Indicator Cards

THE cards shown in the illustrations were taken from a Murray Corliss engine 26 by 48 in, 90 r.p.m. The card shown in Fig. 1 was taken directly from the cylinder by means of a short nipple to which the indicator cock was attached. The expansion line is normal.

When the side pipe and a 3-way cock were used, the card appeared as shown in Fig. 2 with a waved expansion line. Twelve different indicators were used, but in each case the waved expansion line was plainly shown when the side pipe was used.

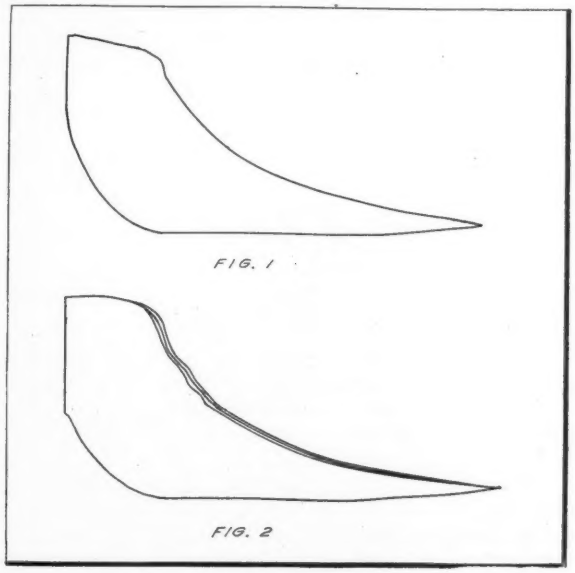


FIG. 1. CARD TAKEN WITH DIRECT CONNECTION TO CYLINDER

FIG. 2. CARD TAKEN WITH SIDE PIPE AND 3-WAY COCK

Cards taken with the same indicators on another engine under similar conditions were normal.

The boilers in the plant in question prime badly; the water can be heard in the cylinder of the engine.

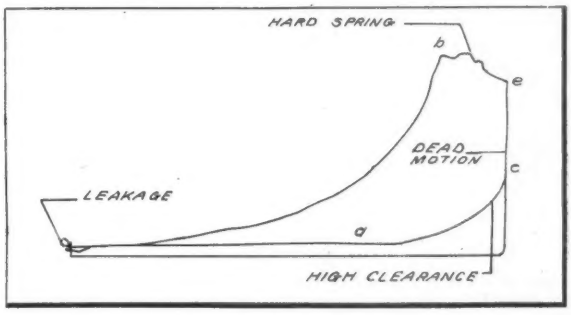
Figs. 3 and 4 show cards taken from the head and crank ends of the cylinder. In Fig. 4 the area of the indicator piston was ½ in. The leak by the piston was excessive. A No. 60 spring was used when taking the cards.

Can some of the readers give an explanation of this phenomena? J. W. Dickson.

Live Questions for Discussion

IS it commercially practical to use over again, for cylinder lubrication, the oil recovered by an oil separator in the exhaust line? If so, please give details and sketch of pipe connections.

2. On inspecting a high-speed automatic engine with riding cut-off and centrifugal governor, it was found that steam could be blown through either one or both indicator cocks, no matter on which stroke or on what part of the stroke the piston was placed, also that when the crank was placed a little less than 45 deg. from the center on the outstroke, as shown in the



PISTON LEAKAGE

figure, and the throttle valve opened, the piston would take steam on the crank end and start backwards, rocking violently for some time.

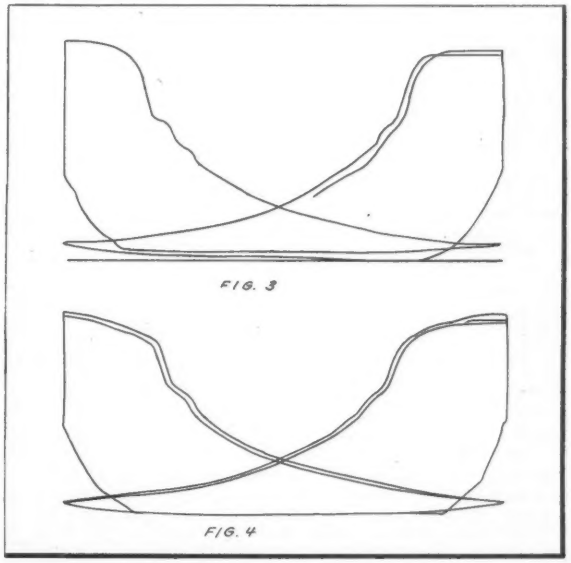


FIG. 3. CARD FROM HEAD AND CRANK END TAKEN UNDER SAME CONDITIONS AS IN FIG. 2

FIG. 4. ANOTHER EXAMPLE OF A CARD TAKEN FROM THE SAME ENGINE

The superintendent claims the valves are tight and correctly set. Is he correct? How much "blow" should be allowed for piston valves and still have them called tight? The engine in question had been shut down for several hours and was turned over by hand.

B. A. T.

PRACTICAL ENGINEER

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.
New York, 150 Nassau St. Cleveland, Am. Trust Bldg.

Subscription Price One Dollar a year in advance to any Post Office in the United States and Mexico or United States possessions.

To Canada One Dollar and Seventy-five Cents; to Other Countries Two Dollars and Fifty Cents a year. Single copies 10 cents.

All persons are warned against paying money for subscriptions to Practical Engineer to anybody unless he has proper credentials signed by the editor, or gives a receipt on regular printed blanks bearing the name Practical Engineer. Bona fide agents never offer subscriptions at less than the advertised price, or combinations other than those shown in our printed subscription circulars.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill. Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

Copyrighted 1912 by Technical Publishing Co.
Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Circulation of this issue, 23,500

CONTENTS

Heating as a Plant Byproduct. Illustrated....283
Routine and Records....290
Heating a Manufacturing Building. Illustrated....292
Low Freezing Temperature Liquids....293
Operating Ammonia Compressors. By E. N. Friedman....294
Thickness of Oil Engine Cylinder Walls....294
Increasing Efficiency. By Lewis A. Danner. Illustrated....295
Heating System Kink. Illustrated....295
Feeding the Boilers from Returns. By H. Armstrong. Illustrated..295
For Water Cooling. Illustrated....296
Oil in Steam Mains Stops Leaks. By Chas. H. Greene....296
An Impolite Air Compressor....296
Producer Effects Great Saving in Operating Costs. By George L. Markland....297
From Reciprocating Engines to Small Turbines....297
Erecting Vertical Engines. By D. J. Kelley. Illustrated....298
A Gas Engine Operating Help....299
Packing a Cylinder Head. By P. E. Merriam. Illustrated....300
Gas Engine Requirements for High Power....301
Heating and Ventilating a Large Bank. Illustrated....302
Training the Marine Engineer. By Isaac N. Cory....304
La France Gasoline-Hydraulic Trucks. Illustrated....306
Furnace for Ice Making Plants. By R. H. Roark....307
The Influence of Injectors on Condenser Work....309
Cement Concrete Vats and Tanks....309
Strength Was Greatest Asset....309
Engine Room Calculations. By Richard Howarth. Illustrated....310
Historic Engine....311
Storage Battery Practice. Illustrated....312
Induction Motor With Two-Phase—Three-Phase Connection. Illustrated....315
"Bill"....315
Who Was Crazy....315
Letters from Engineers: Suction Pipe for Centrifugal Pump. Commutator Sparking Stopped. That License Question. Changing Engine Speed. Cards from a Pumping Engine. Automatic Air Valve on Steam Traps. Steam Line Jog. Stuffing Box as Guide for Water. Revolution Gage. A Pump Experience. Painting a Concrete Floor. Static. A Peculiar Boiler. Reversing the Ice Plant. Unequal Cutoff Caused by Angularity....316
Questions and Answers: Connecting 2 and 3-wire Systems. Compound Engine Troubles. Erecting a Traction Engine. Woolf Engine Valve Gear. Moving Eccentric. Governor and Valve Adjustment....322
Problems for Discussion: Unusual Indicator Cards. Live Questions for Discussion....329
Editorial: Heating Considerations. Commercial Motor Trucks....330
Readers Service Department....331
The Wyoming Separator and Trap. Illustrated....332
Loudon County Council Tramways. Illustrated....333
News Notes....333
Catalog Notes....335

HEATING CONSIDERATIONS

Certainly the winter now passing (?) has been one to turn men's thoughts seriously, rather than lightly, to how best to keep buildings at comfortable temperature—and at reasonable cost. The way coal piles have melted into ashes and cinders in the battle against Boreas and Jack Frost has made the check book shudder and the ink to flow freely.

And as we look ahead, not only our own present comfort and expenditure, but the welfare of future descendants, who must suffer if we waste resources that cannot be replaced, impel us to study how we may heat at least trouble and with least cost.

For large buildings, the problem of distribution has determined on steam as the usual medium, although forced hot water circulation has sometimes been adopted, the reason being the lower temperature at which heat is carried. It is a question in the mind of the writer whether this low temperature of the medium is of any importance so far as heating the air in the room is concerned; but a pound of low-pressure steam gives up more heat in condensing than does a pound of high-pressure, and it is easier to get either from boiler or from exhaust. Also, if from exhaust, the lower the pressure, the more work from the engine. Vacuum system or atmospheric system is, therefore, to be preferred to high-pressure, and modern methods of applying these so as to give the regulation of heat according to climatic condition, make it possible to reduce trouble and save fuel to a remarkable degree. In overhauling and planning for next winter, the possibility of modifying present systems or applying new ones to conform to these modern advantages should be carefully considered.

COMMERCIAL MOTOR TRUCKS

Commercial power trucks for delivery purposes, hauling heavy material, and general trucking have so far invaded the domain of the horse-drawn vehicle, that their manufacture and maintenance has become a large factor in the industrial world.

Advantages of the power truck over horse-drawn wagons have been demonstrated to such an extent that to the most conservative business men they are now apparent. The increasing number of such trucks placed in operation each year has created a demand for men familiar with their construction who are able to attend to their upkeep. In many instances this work might properly belong to the engineer, master mechanic or electrician of a manufacturing establishment, a wholesale or a retail business house and in many diversified business enterprises.

Duties such as would come in connection with the maintenance of motor trucks will naturally broaden the responsibility of men under whom the work comes. Many of the readers of Practical Engineer might profit by such an extension of their duties and the editors have therefore decided to publish a series of articles descriptive of the principal types of commercial trucks, and such accessories as necessarily form a part of their garage equipment. The first article entitled La France Gasoline Hydraulic Trucks appears in this issue.

The editors invite criticism, both favorable and adverse, in connection with this departure and will welcome suggestions for material that in the readers' opinion will add to the value of this department of Practical Engineer.

READER'S SERVICE DEPARTMENT

FOLLOWING is a list of able specialists to whom are referred service questions from inquirers to this department. You have liberty to ask for help from this Readers' Service Department at any time by addressing your troubles to Practical Engineer.

C. F. Swingle, Steam Engine Practice, Chicago. Formerly of Chicago Boiler Inspection Board, Author of Swingle's Handbooks.

Geo. H. Wallace, Engine Installation and Adjustment, Racine, Wis. Formerly Engr. Kelley Racine Rubber Co., Erecting Engr. Wisconsin Eng. Co.

Richard Howarth, The Slide Rule and Marine Practice, Ch. Engr., Providence, R. I.

W. S. Luckenbach, Absorption System Practice, Refrigeration Expert.

J. C. Miller, Expert Tests, Gas Engine Practice, Chicago. Mech. Engr. with Mariner & Hoskins.

W. H. Biesley, Compression System Practice, Paris, Texas. Past Pres. and Examiner, Prac. Ref. Eng.'s Ass'n.

Prof. G. F. Gebhardt, Power Plant Records and Economics, Armour Institute, Chicago.

Prof. R. H. Fernald, Gas Engine and Producer Practice, Case School of App. Science, Cleveland.

P. M. Chamberlain, Combustion Problems, Cons. Engr., Chamberlain & Howell, Chicago.

H. E. Collins, Power Plant Installation and Operation, with Eng'g. Supervision Co., New York.

Sterling H. Bunnell, Shaft Governor Practice, Cons. Engr., New York.

Prof. C. M. Allen, Hydraulic Plant Practice, Worcester, Mass., Worcester Poly. Inst.

S. E. Balcom, Heating and Ventilation, Worcester, Mass. Instructor, Worcester Poly. Inst.

Readers' Service Department answers to four questions asked by a subscriber in regard to an ice plant for a town of 1500 inhabitants.

"What is the approximate size of an ice plant supplying a town of 1500?"

The approximate size of an ice plant for a town of 1500 would depend a great deal on the surrounding territory; but we should consider for ordinary conditions, that a 12 to 15 ton plant would be ample for a city of this size. This would allow you to handle considerable outside territory.

"What would be the approximate cost of the plant?"

The approximate cost of a plant of this size would be about $10,000 to $12,000, depending on the class of machinery selected.

"What is the average cost of producing ice?"

The average cost of producing a ton of ice in a plant of this size, would be governed a great deal by local conditions, and the price of fuel. But with coal at $3 a ton, and the plant operating at its full capacity (15 tons) you should be able to produce a ton of ice for about $1.25.

"What does ice generally sell at, especially in the South?"

Ice delivered, retails at 35c to 50c per 100 lb., and by the ton in less than carload lots $4.50 to $5.00. In car loads $3.00 to $4.50 per ton.

Readers' Service Department answer to return piping questions.

"Should like some information regarding the return pipes from a drying room all of which are connected to the hot water tank. There is no float connected to the city water pipe and the tank overflows half the time. I connected the return pipe to the boiler but cannot make the water enter it. The radiator returns enter this return pipe. The city water with 30 lb. pressure is connected to the heater.

"What changes can I make to secure better results?"

We take it from your letter of Feb. 15, that you use your boiler exclusively to heat the drying rooms and that you carry 80 lb. of steam on the boiler and only about 5 lb. on the radiators. This being the case, it is not possible to operate the equipment in such a manner that the returns will flow back to the boiler. This is possible only when the pressure on the boiler and the radiators is the same and the former is lower than the radiators, when the return water will flow into the boiler by gravity.

The proper way to save your returns, and also the excess water that we understand is now being wasted at least part of the time, is to install a receiver pump of a size that will handle the work with ease, and conduct the return pipes of all the traps on the radiators to the receiver.

Connect the city main to the receiver also in such a manner that the water will pass through a butterfly valve which is operated by the float in the receiver, and when the return water is not sufficient the level of the water in the receiver will fall a small amount, when the butterfly valve will let in enough city water to make up what is required for the boiler.

There would not be any gain by installing a heater, as there is no exhaust steam that can be utilized except the receiver pump and the exhaust of this can be turned into the receiver after having passed it through an exhaust steam oil separator to take out the remains of the cylinder oil used for lubricating the pump. Such a separator is of such a small size that the cost will be very slight, compared with the results obtained.

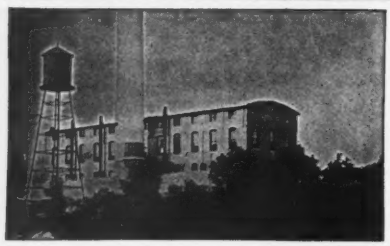
A vent pipe of ample size should be run from the receiver to the atmosphere to carry away excess vapor and also to prevent any difference in pressure that would otherwise occur.

Should the general layout of your plant be such that you can install a feed-water heater at a profit, select one of the open type and locate it in such a manner that the returns from your radiators will flow to it by gravity and also that the hot water will have a fall of about 2 to 4 feet in passing to the pump. Do not try to save on the size of the piping as you will surely make yourself a lot of trouble. Hot water cannot be raised by suction the same as cold water can.

You will find in the advertising section of Practical Engineer reputable concerns who manufacture such apparatus as you will need to overcome your present difficulty, and should you need any further information that we could not give here owing to insufficient data, we will be pleased to assist you.

AT THE ANNUAL MEETING of the board of directors of The Gould Mfg. Company, Seneca Falls, N. Y., held Feb. 26th, all of the officers who have served during the past year were reelected. In the annual report on the business of the year, a slight increase over the preceding year was shown in both the gross amount of sales and net profits.

CLING-SURFACE CO., BUFFALO, N. Y., has issued Bulletin No. 321, a neat folder showing 11 noteworthy installations in Pennsylvania where Cling-Surface is profitably used on belts. Each illustration is accompanied by data concerning the belts shown.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

THE WYOMING SEPARATOR AND TRAP

This is a combination of steam separator and trap which automatically removes the moisture from steam and drains away the water so separated, thus removing possibility of the separator filling up, or the steam reabsorbing water. Evidently this will keep the separator always in condition to handle floods or slugs of water which might pass on to the engine if the water space of the separator were wholly or largely filled.

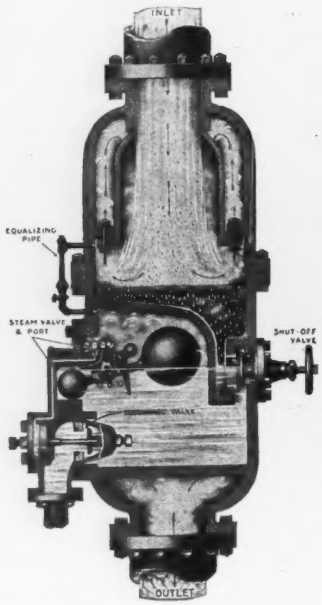


FIG. 1. SECTION OF VERTICAL TYPE, WYOMING AUTOMATIC ELIMINATOR

The Wyoming eliminator is made in horizontal, angle and vertical types, the latter being the most recent development, and arranged as shown in section in Fig. 1, and in actual service on 3 engines just above in the throttle in Fig. 2.

Steam enters the separating chamber from the top, marked inlet and passes down to an enlarged space, where the lower velocity and reversal of direction throw out the moisture, which falls on a perforated baffle and drops to the entrance to the trap section. Dry steam flows upward at the sides, as indicated by the arrows and again reversing turns downward through passages at front and back past the separator and trap sections to the outlet at the bottom.

Water flows to the trap section through a shut off valve, which can be closed when necessary to clean or repair the trap.

When the water reaches a certain level in the trap the float lever trips out the latch and the left hand weight drops about its fulcrum, raising the steam valve and admitting steam to the port. This forces the discharge valve piston to the right, opening the discharge valve and permitting water to flow from the trap.

As the water line lowers the float falls until it reaches its lowest point when the weight is lifted and the weight latch drops in, at the same time unlatching the steam valve and allowing it to close instantly. Steam escapes from the small cylinder into the discharge and the discharge valve is closed by pressure of the water upon it. The valves are thus either wide open or closed tight at all times; and the steam operation of the discharge valve permits of a large area,

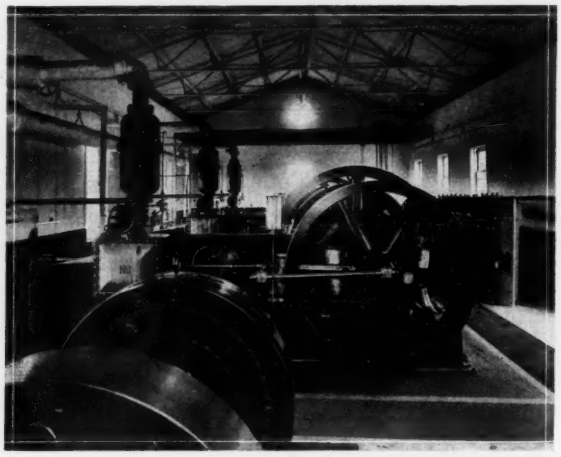


FIG. 2. INSTALLATION OF 3 WYOMING VERTICAL TYPE ELIMNATORS IN PLANT

giving quick emptying of the trap.

These eliminators are made in sizes from 2½ to 16 in. and will operate at pressures from 5 to 150 lb. In the event of flooding the discharge valve will stand wide open until the flow of water has ceased, pressure being maintained through the equalizing pipe which connects the separator section with the trap section.

The Wyoming eliminator is made by W. H. Nicholson & Co., of Wilkes-Barre, Pa., and can be installed on trial under suitable guarantees.

LONDON COUNTY COUNCIL TRAMWAYS

THE London County Council Tramways consists of what was formerly a number of independent tramway undertakings operating within the County of London, together with certain new lines subsequently built by the Council. Each of these Companies owned from 4 to 50 miles of line, but gradu-

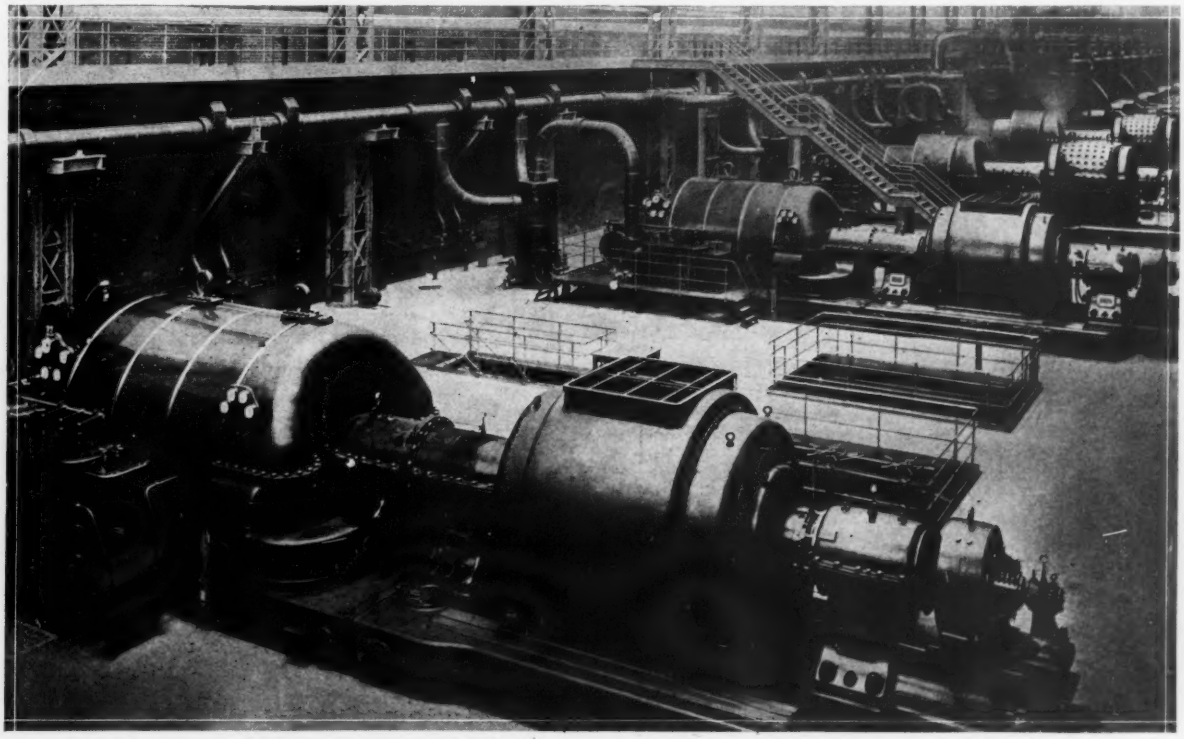
ally the Council has taken over by purchase all the Tramway Companies within its area.

At the end of March 1910, the system extended over 135½ miles of streets of which 115½ miles were electric lines. The remaining 20 miles were at that time still worked by horse traction, but the latter have now practically all been converted to electricity.

Generating Station

THE Electric Generating Station for the whole of London is situated at Greenwich, close to the River Thames. It was erected in two sections, and the site covers an area of approximately 3¾ acres.

The plant includes four vertical horizontal reciprocating engines coupled to three-phase alternators, of 3,000 kw. capacity each and four 3-phase turbo alternators of 5,000 kw. capacity. Two of the latter have only recently been installed. They were manufactured by the British Westinghouse Electric & Manufacturing Company, Limited, of Trafford Park, Manchester. An illustration of one of these sets appears in the accompany illustration.



INTERIOR OF GREENWICH POWER STATION OF THE LONDON COUNTY COUNCIL TRAMWAYS

The two sets each comprise one 5,000 kw. 750 r.p.m. high pressure Westinghouse Impulse Type Turbine coupled to one 5000 kw. three-phase 25-cycle 6600-v., alternator, complete with Leblanc Surface Condensing plant and Leblanc auxiliaries.

The normal plant capacity of the Greenwich Generating Station is 34,000 kw. The current is generated at a pressure of 6,600 volts, and is conveyed to various sub-stations over the tramway area.

The sub-stations are provided with motor generators and rotary converters of a total capacity of 45,750 kw. transforming the current from alternating to direct at a pressure of from 550 to 600 volts.

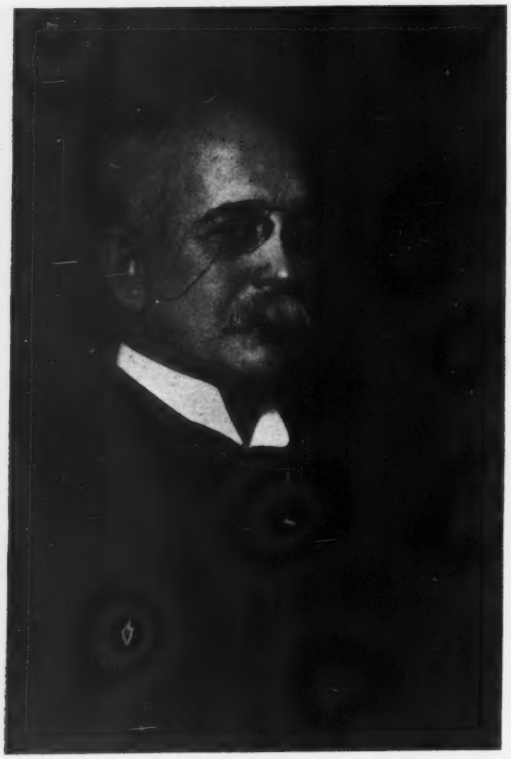
The current is sent in the usual way from low tension switchboard through feeder cables which feed into the conductor rails in the conduit at half-mile intervals. On the over-head wire section the usual feeding arrangements for trolley wires are in use. The switches on the feeder panels in the sub-stations allow the conductor bars in the conduit to be changed so that either may be positive or negative as required for the purpose of dealing with leakages to earth.

NEWS NOTES

EXAMINATIONS ARE TO BE HELD for the following positions by the United States Civil Service Commission at various cities where examining boards are maintained. Full information can be had by writing to the Commission, Washington, D. C. On March 20 and 21, assistant chemical engineer in forest products, salary $1200 and $1500 a year. Duty at Madison, Wis. The subjects will be chemical engineering calculations, mechanical, electrical and chemical laboratory practice, mechanics, physics, plant design and drafting. Engineer in forest products, March 20 and 21, salary $1600 to $2500 a year for duty at Madison, Wis., subjects for examination being machine design, wood preservation, saw mill and logging operations, training, experience and fitness. Assistant engineer in forest products, salary $1200 to $1500 for duty at Madison, Wis., subjects being practically the same as for the engineer except the examination will be along more elementary lines. Laboratory aid and engineer, salary of $900, for employment at Madison, subjects of examination being arithmetic, operation and care of boilers, motors, shafting, etc., and practical experience.

FROM MARCH 20-22, examination will be held by the U. S. Civil Service Commisson for mechanical and electrical engineer, salary $1800 to $2000 a year, in the quartermaster's department at large, New London, Conn., age limit 25 years or over Subjects will include mathematics, including algebra and calculus, problems in mechanics, electrical and mechanical engineering, designs in electrical and mechanical construction, ability to make neat scale drawings and to determine sizes and types of apparatus best adapted for certain requirements, specifications covering electrical and mechanical engineering construction, and testing of apparatus. The appointee must be competent to draw plans and specifications for power and electrical installations, superintend the installations and make operating tests. At least 5 yr. practical experience will be required. Candidates must furnish slide rule, drawing board 18 by 24 in., India ink and necessary drawing instruments. Three days are required for the examination. The examination may be taken in any of the principal cities of the country. Applicants should apply to the U. S. Civil Service Commission, Washington, D. C., for application and examination from No. 1312.

HEREWITH IS THE likeness of Francis H. Stillman, notice of whose death appeared in the March 1 issue, the photograph coming too late to permit making the cut in time for that issue. Those who knew him in life will realize with keen regret that Mr. Stillman's pleasant



greeting with kindly smile and warm handclasp will meet them no more at the meetings of societies where he has been so frequent and prominent a figure.

IN REGARD TO THE suit for the infringement of the Van Auken patents which has been pending for some 3 yr., the United States Circuit Court of Appeals has handed down a decision that the Monash radifier valve is not an infringement on these patents.

THE TOWN OF JOHNSON, R. I., is about to install water works and will use electric pumping units, and construct a small reservoir to hold 500,000 gallons. Mr. Memmert is in charge of the work.

FIRE DESTROYED HALF a million gallons of lubricating oil, Feb. 18th, at the plant of the Atlantic Refining Co. of Philadelphia, Pa. Estimated loss is $80,000.

IN HONOR OF the fiftieth anniversary of the founding of the company, The Lunkenheimer Co., of Cincinnati, Ohio, tendered its employes and families an elaborate entertainment and dance, Saturday evening, Feb. 17. Over 4000 people attended. The event was given at the O. N. G. Armory, which is the largest hall for events of this kind in Cincinnati. Provision was made for the entertainment of the employes' children and they were present in large numbers. Refreshments to meet the taste of the men, women and children were served in great abundance.

TRADE NOTES

THE METROPOLITAN (the West Side) ELEVATED RAILWAY. COMPANY, Chicago, has recently ordered from the Golden-Anderson Valve Specialty Co., Pittsburgh 13 ten inch triple acting non-return valves, making a total of 26 of these well known valves purchased for the perfection of their power station.

THE PITTSBURGH STEEL CO. after a thorough investigation, has placed an order with Golden-Anderson Valve Specialty Co., Pittsburgh, for 28 eight inch triple-acting non-return valves. This order follows an installation of these non-return valves furnished the Pittsburgh Steel Co. three years ago.

CATALOG NOTES

INGERSOLL-RAND CO., 11 Broadway, N. Y. City. Bulletin 4111, 16 pages, 6 by 9 descriptive of type "BC" Butterfly Hammer Drills. These drills are equipped with telescope feed and can also be furnished with dust allayers, which are strongly advocated as a safe guard to the health of the miners. Water can be sucked up 6 or 8 ft. from a pail or bucket, no tank or pressure line being necessary. This makes the use of the water spray possible under all conditions, no matter how small the working or how far away from the source of water supply. The Butterfly Valve consists of 2 wings and a central stem on which it oscillates. One wing controls the supply to each end of the cylinder, the other wing controlling the exhaust. As the 2 wings are of the same area, the pressure holding the supply wing on its seat is equaled by the pressure tending to force the exhaust wing off its seat, thus making a balanced valve which requires little pressure to shift it. The valve closes the ports by advancing to the seat, not by sliding on the seat, thus making a better fit the longer it runs. All exhaust is at one point, and directed back parallel to the feed cylinder, minimizing the tendency to scatter dust. This positiveness and simplicity of valve action is a very desirable feature. The catalog shows sectional views of machine and also several cuts of machine at work underground, together with list of duplicate parts.

IN ORDER TO SUPPLY the constantly increasing demand for information relating to the methods used by the Bureau of Mines in analyzing coal and coke, the buerau has just issued Technical Paper No. 8, by Frederick M. Stanton and Arno C. Fieldner. This Technical Paper describes the methods in use at the laboratories of the bureau for analyzing coal and coke, and determining the heating value of these fuels.

The fuel investigations being conducted by the Bureau of Mines had their inception in the work done at the Government coal-testing plant erected in 1904, at the Louisiana Purchase Exposition, St. Louis, Missouri, and the analytical methods originally used by the chemists at that plant have been followed without much change in the subsequent chemical work of the fuel-testing plants at St. Louis, Norfolk and Pittsburgh. The paper describes the original methods (which were those recommended by the committee on coal analysis of the American Chemical Society) and such modifications and changes as experience has shown advisable.

Copies of Technical Paper No. 8 may be obtained by writing to the Director of the Bureau of Mines, Washington, D. C.

COCHRANE HEATERS, THEIR USE IN STEAM POWER PLANTS for Heating and Purifying Water for Boiler Feed and Other Purposes, a 144-page publications issued by the Harrison Safety Boiler Works, 3144 North St., Philadelphia, contains undoubtedly the most complete account of what may be called "exhaust steam engineering" that has ever appeared. The range of topics includes as subjects: The choice of a system for heating boiler feed water; the relative economy of electric and direct-driven auxiliaries vs. steam-driven auxiliaries where the exhaust from the latter is used for heating the boiler feed water; the action of spraying the water through a steam bath in driving off air and gases and thereby preventing corrosion as well as bringing about the precipitation of carbonates from the water; a comparison of the thermal efficiencies of direct-acting pumps, throttling plain slide-valve engines, automatic engines, compound engines and steam turbines; the effect upon fuel economy of heating boiler feed water; the steaming capacity of boilers; apparatus for utilizing exhaust steam, including feed-water heaters, oil separators, traps, return tanks and automatic cold water regulators; the influence of scale upon boiler repair bills; the heating of feed water in condensing plants; the utilization of exhaust steam for heating and drying work, and for the operation of low-pressure turbines, the operation of open feed-water heaters in multiple; the pumping of hot water; the limitations of injectors; a point-by-point comparison of the efficiencies and other characteristics of open feed-water heaters; an analysis of the design of the several parts of an open feed-water heater; an analysis of the fundamental facts of water softening as it affects central stations, manufacturing plants, etc.; the metering of boiler feed water; etc.

The catalog naturally describes the several appliances manufactured by the Harrison Safety Boiler Works for use in connection with the above mentioned branches of engineering, including the Cochrane Open Feed-Water Heaters; Steam-Stack and Cut-Out Valve Heaters and Receivers; Sorge-Cochrane Hot Process Softening Systems; Cochrane Steam and Oil Separators; and the Cochrane Multiport Safety Exhaust Outlet Valves for Back Pressure and Vacuum Service. Copies of this elaborate treatise are sent free to owners, engineers and operators of steam plants, and others having direct interest in the subjects treated.

A BLUE BOOK of facts and figures published by H. W. Johns-Manville Co., discusses the amount of power consumed in the stuffing boxes around rods on machinery and shows the detailed construction of the J-M Sea rings and their action in reducing friction to a minimum. It speaks also of other styles of packing made by the H. W. Johns-Manville Co., and of the economy in power by their use.

HEREWITH IS REPRODUCED a picture of the front cover of an artistic and interesting booklet which tells what scale does to boilers in the way of cutting down efficiency and making trouble generally. Every engineer has some trouble with scale deposit or with

pitting. The booklet mentioned shows why these things occur and how Perolin helps in either emergency. Copies may be had by writing to the Perolin Co., of America, 1112 W. 37th St., Chicago, and mentioning Practical Engineer.

"VITRIBESTOS" or in its longer form petrified asbestos is a title given to a booklet issued by the H. W. Johns-Manville Co., and known as catalog No. 108. This booklet tells of the use of the material for air-cell coverings, for smoke stack linings, for pipe covering, as protection for brick, for boiler coverings, for ceilings and for general fire proofing and insulation.

J-M SECTIONAL CONDUIT, a complete underground pipe covering system is shown in catalog No. 112 of the H. W. Johns-Manville Co. This conduit is for insulating pipes conveying steam, water, gas or liquids and complete details of construction are shown including the conduit itself, the frames for supporting it, methods of making joints, plans of some representative installations, comparison of saving effected. For any one having an underground installation in view, the book will be found interesting and helpful and even for those who have no present installation in view, the knowledge will likely come in handy at some time when a problem of utilization of exhaust steam or the distribution of hot water arises.

N. T. C. BULLETIN NO. 4, contains a paper by Rear Admiral John D. Board, presented before American Society of Naval Engineers on the subject "Corrosion of Boiler Tubes." It is an interesting report of a number of tests and of the conditions found and can be had by writing to the National Tube Co., Frick Bldg. Pittsburgh, Pa.

NATIONAL CABLE & MFG. CO., of Niles, Mich., is sending out catalogs of the Duplex Positive Pressure Blower which is a rotary type having sliding vanes working in and out of a rotating cylinder set in an eccentric casing.

SPRAGUE ELECTRIC WORKS of The General Electric Co., issues a catalog on Sprague Electric Fans which is a beautiful publication from cover to cover. It deals in detail with the different types, sizes and arrangements of the Sprague Fan from the little 8-in. telephone booth and desk fans through the 56-in 4-bladed ceiling and column stands, showing stationery and oscillating types and giving the voltages, speeds and cost of the different styles and sizes. In view of the coming hot weather it will be an interesting book for study of those having the fan problem in mind.

THE ENGINEERING DEPARTMENT of the National Electric Lamp Association has recently issued Bulletin 19, illustrating and describing the electric luminous radiator, and calling attention to the many ways in which it may be made a convenience in the home. A table of data on luminous radiator lamps in regard to size, wattage, voltage, etc., is inserted. Copies of this bulletin may be obtained from the Engineering Department upon request.

FROM WATSON & McDANIEL CO., 146 N. 7th St., Philadelphia, comes its catalog No. 21 of steam specialties for power plants and steam heating. This is a convenient pocket sized catalog, showing the McDaniel steam traps for light and heavy duty, Columbia expansion steam trap, McDaniel exhaust pipe head, Watson reducing valves of various types for high and low pressure, steam pump governors, and the W. & McD. specialties including siphon pumps, separators, blow-off valves, etc. It is an interesting line of specialties and is fully described in the catalog.

THE NEW CATALOG of the Dodge Manufacturing Co., is now being distributed among the trade. It is 413 pages, beautifully printed and illustrated, and describes and lists in complete form the goods the Dodge people make at Mishawaka, Indiana, including power transmission machinery and appliances, elevating and conveying equipment, rope driving system, and water softener apparatus.

THE SAFE CLUTCH is the title given to the Ewart friction clutch by its manufacturers, the Link Belt Co., and described in Book No. 121 issued by that company. This clutch is guaranteed and has several striking features, such as freedom from projecting parts to catch the clothing and, if desired, all clutch mechanism housed to prevent meddling or interference. Second, a grip on a rim at a considerable distance from the shaft to give large torque; third, instant release which permits of instant stopping of machinery, an important advantage in case of accident to work, machinery or men. The book illustrates the mechanism of the clutch and shows its application to pulleys in different styles. It may be had by addressing the Link Belt Co., Chicago, Ill.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—As engineer in electric light or ice plant. Am married, sober and not afraid of work. Eight years' experience. Own an indicator and know how to use it. Would prefer southwest. W. G. Parr, No. Baltimore, O. 3-15-1

POSITION WANTED—By engineer with 12 years' practical experience with high speed and Corliss engines, A. C. and D. C. generators. In present plant 7 years, but wish to change to larger plant. 40 years old, married and sober. Address Box 210, Practical Engineer, Chicago, Ill. 3-15-1

POSITION WANTED—As engineer, by man 26 years of age, having 5 years' experience with Corliss and high speed engines, alternating and direct current dynamos, boilers and pumps. Can do line work. Strictly sober and steady. 4 years in plant where at present employed. Address Box 211, Practical Engineer, Chicago, Ill. 3-15-2

Wanted

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. 3-15-2

MANUFACTURERS' AGENTS to handle thoroughly guaranteed steam specialties; feed water heaters, steam and oil separators, traps and exhaust pipe heads; not necessary to represent entire line if interested in only part of it; our specialties are well advertised and of good reputation. Address Box 204, Practical Engineer, Chicago. 3-15-1

WANTED—75 or 100 K. W. Unit, Direct Current, Direct Connected, 250 volts. State price and particulars. Address, Turner Brass Works, Sycamore, Ill. 3-15-1

WANTED—EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one and two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. 3-15-1

Miscellaneous

MAKE MONEY on the side. Here's your chance to pick out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. 1-15-3

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write to-day. M. Y. C., 1413 W. Jackson Blvd., Chicago, Ill.